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DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648-XC564

Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to Marine Seismic Survey in the Beaufort Sea, Alaska

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Notice; proposed incidental harassment authorization; request for comments.

SUMMARY: NMFS received an application from SAExploration, Inc. (SAE) for an Incidental Harassment Authorization (IHA) to take marine mammals, by harassment only, incidental to a marine 3-dimensional (3D) ocean bottom cable (OBC) seismic surveys program in the state and federal waters of the Beaufort Sea, Alaska, during the open water season of 2013. Pursuant to the Marine Mammal Protection Act (MMPA), NMFS is requesting comments on its proposal to issue an IHA to SAE to take, by Level B harassment, nine species of marine mammals during the specified activity.

DATES: Comments and information must be received no later than [insert date 30 days after date of filing for public inspection with the OFFICE OF THE FEDERAL REGISTER].

ADDRESSES: Comments on the application should be addressed to P. Michael Payne, Chief, Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service, 1315 East-West Highway, Silver Spring, MD 20910. The mailbox address for providing email comments is ITP.guan@noaa.gov. NMFS is not responsible for e-mail comments sent to addresses other than the one provided here. Comments sent via e-mail,

including all attachments, must not exceed a 10-megabyte file size.

Instructions: All comments received are a part of the public record and will generally be posted to <http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications> without change. All Personal Identifying Information (for example, name, address, etc.) voluntarily submitted by the commenter may be publicly accessible. Do not submit Confidential Business Information or otherwise sensitive or protected information.

The application used in this document may be obtained by visiting the internet at: <http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications>. Documents cited in this notice may also be viewed, by appointment, during regular business hours, at the aforementioned address.

FOR FURTHER INFORMATION CONTACT: Shane Guan, Office of Protected Resources, NMFS, (301) 427-8401.

SUPPLEMENTARY INFORMATION:

Background

Sections 101(a)(5)(A) and (D) of the MMPA (16 U.S.C. 1361 *et seq.*) direct the Secretary of Commerce to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and either regulations are issued or, if the taking is limited to harassment, a notice of a proposed authorization is provided to the public for review.

Authorization for incidental takings shall be granted if NMFS finds that the taking will have a negligible impact on the species or stock(s), will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses (where relevant), and if the

permissible methods of taking and requirements pertaining to the mitigation, monitoring and reporting of such takings are set forth. NMFS has defined “negligible impact” in 50 CFR 216.103 as “...an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival.”

Section 101(a)(5)(D) of the MMPA established an expedited process by which citizens of the U.S. can apply for an authorization to incidentally take small numbers of marine mammals by harassment. Section 101(a)(5)(D) establishes a 45-day time limit for NMFS review of an application followed by a 30-day public notice and comment period on any proposed authorizations for the incidental harassment of marine mammals. Within 45 days of the close of the comment period, NMFS must either issue or deny the authorization.

Except with respect to certain activities not pertinent here, the MMPA defines “harassment” as: any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [“Level A harassment”]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [“Level B harassment”].

Summary of Request

On December 12, 2012, NMFS received an application from SAE requesting an authorization for the harassment of small numbers of marine mammals incidental to conducting an open water 3D OBC seismic survey in the Beaufort Sea off Alaska. After addressing comments from NMFS, SAE modified its application and submitted a revised application on April 14, 2013. SAE’s proposed activities discussed here are based on its

April 14, 2013, IHA application.

Description of the Specified Activity

The planned 3D seismic survey would occur in the nearshore waters of the Colville River Delta in the Alaskan Beaufort Sea (Figure 1-1 of SAE's IHA application). The components of the project include laying nodal recording sensors (nodes) on the ocean floor, operating seismic source vessels towing active airgun arrays, and retrieval of nodes. There will also be additional boat activity associated with crew transfer, recording support, and additional monitoring for marine mammals.

A total of 210 nodal (receiver) lines will be laid perpendicular from the shoreline spaced 200 to 268 m (660 to 880 ft) apart. Receiver line lengths range between 20 and 32 km (13 and 20 mi) long. The total receiver area is 1,225 km² (473 mi²). Sixty-five source (shot) transect lines will run perpendicular to the receiver nodal lines, each spaced 300 to 335 m (990 to 1,100 ft) apart. These lines will be approximately 51 km (32 mi) long. The total source survey area is 995 km² (384 mi²).

The receiver layout and seismic survey data will be acquired using the stroke technique -- multiple strokes with 6 receiver lines per stroke. Source lines will be acquired perpendicular to the receiver lines for each stroke, only 6 receiver lines will be laid at a time, with enough associated source survey to fully acquisition data for that stroke. Once data is acquired for a given stroke, the nodal lines (strings of individual nodes tethered together by rope) will be retrieved and repositioned into a second 6 line stroke, and the seismic survey operations begin anew. This will allow the most rapid acquisition of data using the minimum number of active nodes.

Acoustical Sources

The acoustic sources of primary concern are the airguns that will be deployed from the seismic source vessels. However, there are other noise sources to be addressed including the pingers and transponders associated with locating receiver nodes, as well as propeller noise from the vessel fleet.

The seismic sources to be used will include using 880 and 1,760 cubic inch (in³) sleeve airgun arrays for use in the deeper waters, and a 440 in³ array in the very shallow (<1.5 m) water locations. The arrays will be towed approximately 15 to 22 m (50 to 75 ft) behind the source vessel stern, at a depth of 4 m (12 ft), and towed along predetermined source lines at speeds between 4 and 5 knots. Two vessels with full arrays will be operating simultaneously in an alternating shot mode; one vessel shooting while the other is recharging. Shot intervals are expected to be about 8 to 10 seconds for each array resulting in an overall shot interval of 4 to 5 seconds considering the two arrays. Operations are expected to occur 24 hours a day.

Based on the manufacturer's specifications, the 440 in³ array has a peak-peak estimated 1-meter sound source of 239.1 dB re 1 μPa, and root mean square (rms) at 221.1 dB re 1 μPa. The 880 in³ array produces sound levels at source estimated at peak-peak 244.86 dB re 1 μPa @ 1 m, and rms at 226.86 dB re 1 μPa. The 1,760 in³ array has a peak-peak estimated sound source of 254.55 dB re 1 μPa @ 1 m, with an rms sound source of 236.55 dB re 1 μPa. The 1,760 in³ array has a sound source level approximately 10 dB higher than the 880 in³ array.

Pingers and Transponders

An acoustical pinger system will be used to position and interpolate the location of the nodes. Pingers will be positioned at predetermined intervals throughout the shoot patch

and signals transmitted by the pingers will be received by a transponder mounted on a recording and retrieving vessel. The pingers and transponder communicate via sonar and, therefore, each generates underwater sounds potentially disturbing to marine mammals. The exact model of pinger system to be used is yet to be determined, but available pingers transmit short pulses at between 19 to 55 kHz and have published source levels between 185 and 193 dB (rms) re 1 μ Pa @ 1 m. Available transponders generally transmit at between 7 and 50 kHz, with similar source levels also between 185 and 193 dB re 1 μ Pa @ 1 m. Aerts *et al.* (2008) measured the sound source signature of the same pingers and transponders to be used in this survey and found the pinger to have a source level of 185 dB re 1 μ Pa and the transponder at 193 dB re 1 μ Pa.

Both the pingers and the transponders produce noise levels within the most sensitive hearing range of seals (10 to 30 kHz; Schusterman 1981) and beluga whales (12 to ~100 kHz; Wartzok and Ketten 1999), and the functional hearing range of baleen whales (20 Hz to 30 kHz; NRC 2003), although baleen whale hearing is probably most sensitive nearer 1 kHz (Richardson *et al.* 1995). However, given the low acoustical output, the range of acoustical harassment to marine mammals is between about 24 to 61 m (80 and 200 ft), or significantly less than the output from the airgun arrays (see below).

Vessels

Several offshore vessels will be required to support recording, shooting, and housing in the marine and transition zone environments. The exact vessels that will be used have not yet been determined. However, the types of vessels that will be used to fulfill these roles are listed in Table 1.

Source Vessels - Source vessels will have the ability to deploy two arrays off the

stern using large A-frames and winches and have a draft shallow enough to operate in waters less than 1.5 m (5 ft) deep. On the source vessels the airgun arrays are typically mounted on the stern deck with an umbilical that allow the arrays to be deployed and towed from the stern without having to re-rig or move arrays. A large bow deck will allow for sufficient space for source compressors and additional airgun equipment to be stored. The two marine vessels likely to be used are the Peregrine and Miss Diane. Both were acoustically measured by Aerts et al. (2008). The Peregrine was found to have a source level of 179.0 dB re 1 μ Pa, while the smaller Miss Diane has a source level of 165.7 dB re 1 μ Pa.

Table 1. Vessels to be used during SAE’s 3D OBC seismic surveys.

Vessel	Size (ft)	Activity and Frequency	Source Level (dB)
Source vessel 1	120 x 25	Seismic data acquisition; 24 hr operation	179
Source vessel 2	80 x 25	Seismic data acquisition; 24 hr operation	166
Node equipment vessel 1	80 x 20	Deploying and retrieving nodes; 24 hr operation	165
Node equipment vessel 2	80 x 20	Deploying and retrieving nodes; 24 hr operation	165
Mitigation/housing vessel	90 x 20	House crew; 24 hr operation	200
Crew transport vessel	30 x 20	Transport crew; intermittent 8 hrs	192
Bow picker 1	30 x 20	Deploying & retrieving nodes; intermittent operation	172
Bow picker 2	30 x 20	Deploying & retrieving nodes; intermittent operation	172

Recording Deployment and Retrieval - Jet driven shallow draft vessels and bow pickers will be used for the deployment and retrieval of the offshore recording equipment. These vessels will be rigged with hydraulically driven deployment and retrieval squirters allowing for automated deployment and retrieval from the bow or stern of the vessel. These vessels will also carry the recording equipment on the deck in fish totes. Aerts et al. (2008) found the recording and deployment vessels to have a source level of approximately 165.3

dB re 1 μ Pa, while the smaller bow pickers produce more cavitation resulting in source levels of 171.8 dB re 1 μ Pa.

Housing and Transfer Vessels - Housing vessel(s) will be larger with sufficient berthing to house crews and management. The housing vessel will have ample office and bridge space to facilitate the role as the mother ship and central operations. Crew transfer vessels will be sufficiently large to safely transfer crew between vessels as needed. Aerts et al. (2008) found the housing vessel to produce the loudest propeller noise of all the vessels in the fleet (200.1 dB re 1 μ Pa), but this vessel is mostly anchored up once it gets on site. The crew transfer vessel also travels only infrequently relative to other vessels, and is usually operated at different speeds. During higher speed runs the vessel produces source noise levels of about 191.8 dB re 1 μ Pa, while during slower on-site movements the vessel source levels are only 166.4 dB re 1 μ Pa (Aerts et al. 2008).

Mitigation Vessel - To facilitate marine mammal monitoring of the Level B harassment zone, one dedicated vessel will be deployed a few kilometers northeast of the active seismic source vessels to provide a survey platform for 2 or 3 Protected Species Observers (PSOs). These PSOs will work in concert with PSOs stationed aboard the source vessels, and will provide an early warning of the approach of any bowhead whale, beluga, or other marine mammal. It is assumed that the vessel will be of similar size and acoustical signature as a bowpicker.

Acoustic Footprint

SAE used the JASCO model provided in Aerts et al. (2008) to predict its source levels for the 880 and 1,760 in³ airgun array, corrected with the measured or manufacture's source levels. For the 440-in³ and 880-in³ arrays, the choices were to either use the radii

values already determined by Aerts et al. (2008), further choosing between the 50th or 100th percentile values, or applying factory-measured sound source levels to the model. Aerts et al. (2008) did not measure the 1,760-in³ array, so the former choice is not available for this array.

While NMFS and SAE considered using the 100th percentile values generated by Aerts et al. (2008) to estimate the airgun array source would have the benefit of being the most protective approach, it was not used because the estimated value from this model is very unlikely to represent the actual source level as the model is based on far-field measurements. In addition, a close examination of the endfire measurements in Figure 3.4 provided by Aerts et al. (2008) show that the measured values within 600 m of the source nearly all fall along or below the 50th percentile line, while the 100th percentile is influenced by values between 600 and 1,000 m. Therefore, NMFS believes that the 50th percentile or 230.9 dB is closer to the actual source level of the 880-in³ airgun array, which was also supported by the 550 m of measurements (between 50 and 600 m) during the BP's sound source verification (SSV) measurements reported by Aerts et al. (2008). The modeled source levels of 230.9 dB for the 880-in³ array is still higher than the manufacture source value for the SeaScan 880-in³ array (peak to peak 17.5 bar-m, which is roughly equivalent to 226.86 dB rms).

Applying the 230.9 dB modeled source level for the 880 in³ array to JASCO's modeled propagation equation for the same volume of airgun array,

$$18 \text{ Log}(R) - 0.0047(R)$$

(where R is the range in meter from the source), which was based on BP's SSV measurements (Aerts et al. 2008), results in exclusion zone radii of 167 m (190 dB) and 494

m (180 dB).

Similar modeling effects were done on the 440-in³ array, which results in exclusion zone radii of 126 m (190 dB) and 325 m (180 dB).

However, this approach does not work for establishing safety radii for the 1,760-in³ array as Aerts *et al.* (2008) did not measure such an array. Using the manufacturer source value of 236.6 dB rms and the JASCO model, $18 \text{ Log}(R) - 0.0047(R)$, yields safety radii of 321 m (190 dB) and 846 m (180 dB).

A similar method was used to calculate the estimated 160 dB radii for the three different volumes of airgun arrays. A summary of airgun array modeled source levels and their respective exclusion zones are listed in Table 2.

Table 2. Modeled airgun array source levels and exclusion zone and zones of influence radii

Array size (in ³)	Source level (dB)	190 dB radius (m)	180 dB radius (m)	160 dB radius (m)
440	221.10	126	325	1,330
880	226.86	167	494	1,500
1,760	236.55	321	842	2,990

While the pingers and transponders that will be used to relocate nodes generate sound source levels at approximately 185 to 193 dB re 1 μ Pa, the associated exclusion zones are estimated at about 0 to 6 m from the source.

Dates and Duration of the Proposed Seismic Survey

SAE's proposed 3D OBC seismic survey is for the 2013 open water season between July 1 and October 15. All associated activities, including mobilization, survey activities, and demobilization of survey and support crews, would occur inclusive of the above dates. The actual data acquisition is expected to take approximately 70 days (July 25 to September 30), dependent of weather. Based on past similar seismic shoots in the Beaufort Sea, it is

expected that effective shooting would occur over about 70 percent of the 70 days (or about 1,176 hours). If required in the Conflict Avoidance Agreement (CAA), surveys will temporarily cease during the fall bowhead whale hunt to avoid acoustical interference with the Cross Island, Kaktovik, or Barrow based hunts. Still, seismic surveys will begin in the more offshore areas first with the intention of completing survey of the bowhead whale migration corridor (waters >15 meters deep) region prior to the arrival of the fall migration. It is expected that by September 1, the northernmost 8 to 10 kilometers of the survey box will have been shot, with the remaining area to be surveyed found 5 to 8 kilometers south of the southern edge of the bowhead migration corridor (the 15-meter isobath).

Description of Marine Mammals in the Area of the Specified Activity

The marine mammal species under NMFS jurisdiction most likely to occur in the seismic survey area include five cetacean species, beluga whale (*Delphinapterus leucas*), narwhal (*Monodon monoceros*), bowhead whale (*Balaena mysticetus*), gray whale (*Eschrichtius robustus*), and humpback whale (*Megaptera novaeangliae*), and four pinniped species, ringed (*Phoca hispida*), spotted (*P. largha*), bearded (*Erignathus barbatus*), and ribbon seals (*Histiophoca fasciata*).

The bowhead and humpback whales are listed as “endangered”, and the ringed and bearded seals are listed as “threatened” under the Endangered Species Act (ESA) and as depleted under the MMPA. Certain stocks or populations of gray and beluga whales and spotted seals are also listed under the ESA, however, none of those stocks or populations occur in the proposed activity area.

SAE’s application contains information on the status, distribution, seasonal distribution, and abundance of each of the species under NMFS jurisdiction mentioned in this

document. Please refer to the application for that information (see ADDRESSES).

Additional information can also be found in the NMFS Stock Assessment Reports (SAR).

The Alaska 2012 SAR is available at: <http://www.nmfs.noaa.gov/pr/sars/pdf/ak2012.pdf>.

Potential Effects of the Specified Activity on Marine Mammals

Operating active acoustic sources such as airgun arrays, navigational sonars, and vessel activities have the potential for adverse effects on marine mammals.

Potential Effects of Airgun Sounds on Marine Mammals

The effects of sounds from airgun pulses might include one or more of the following: tolerance, masking of natural sounds, behavioral disturbance, and temporary or permanent hearing impairment or non-auditory effects (Richardson *et al.* 1995). As outlined in previous NMFS documents, the effects of noise on marine mammals are highly variable, and can be categorized as follows (based on Richardson *et al.* 1995):

(1) Behavioral Disturbance

Marine mammals may behaviorally react to sound when exposed to anthropogenic noise. These behavioral reactions are often shown as: changing durations of surfacing and dives, number of blows per surfacing, or moving direction and/or speed; reduced/increased vocal activities; changing/cessation of certain behavioral activities (such as socializing or feeding); visible startle response or aggressive behavior (such as tail/fluke slapping or jaw clapping); avoidance of areas where noise sources are located; and/or flight responses (e.g., pinnipeds flushing into water from haulouts or rookeries).

The biological significance of many of these behavioral disturbances is difficult to predict, especially if the detected disturbances appear minor. However, the consequences of behavioral modification could be expected to be biologically significant if the change affects

growth, survival, and reproduction. Some of these potential significant behavioral modifications include:

- Drastic change in diving/surfacing patterns (such as those thought to be causing beaked whale stranding due to exposure to military mid-frequency tactical sonar);
- Habitat abandonment due to loss of desirable acoustic environment; and
- Cease feeding or social interaction.

For example, at the Guerrero Negro Lagoon in Baja California, Mexico, which is one of the important breeding grounds for Pacific gray whales, shipping and dredging associated with a salt works may have induced gray whales to abandon the area through most of the 1960s (Bryant et al. 1984). After these activities stopped, the lagoon was reoccupied, first by single whales and later by cow-calf pairs.

The onset of behavioral disturbance from anthropogenic noise depends on both external factors (characteristics of noise sources and their paths) and the receiving animals (hearing, motivation, experience, demography) and is also difficult to predict (Southall et al. 2007).

Currently NMFS uses 160 dB re 1 μ Pa (rms) at received level for impulse noises (such as airgun pulses) as the threshold for the onset of marine mammal behavioral harassment.

In addition, behavioral disturbance is also expressed as the change in vocal activities of animals. For example, there is one recent summary report indicating that calling fin whales distributed in one part of the North Atlantic went silent for an extended period starting soon after the onset of a seismic survey in the area (Clark and Gagnon 2006). It is

not clear from that preliminary paper whether the whales ceased calling because of masking, or whether this was a behavioral response not directly involving masking (i.e., important biological signals for marine mammals being “masked” by anthropogenic noise; see below). Also, bowhead whales in the Beaufort Sea may decrease their call rates in response to seismic operations, although movement out of the area might also have contributed to the lower call detection rate (Blackwell et al. 2009a; 2009b). Some of the changes in marine mammal vocal communication are thought to be used to compensate for acoustic masking resulting from increased anthropogenic noise (see below). For example, blue whales are found to increase call rates when exposed to seismic survey noise in the St. Lawrence Estuary (Di Iorio and Clark 2009). The North Atlantic right whales (*Eubalaena glacialis*) exposed to high shipping noise increase call frequency (Parks et al. 2007) and intensity (Parks et al. 2010), while some humpback whales respond to low-frequency active sonar playbacks by increasing song length (Miller et al. 2000). These behavioral responses could also have adverse effects on marine mammals.

Mysticetes: Baleen whales generally tend to avoid operating airguns, but avoidance radii are quite variable. Whales are often reported to show no overt reactions to airgun pulses at distances beyond a few kilometers, even though the airgun pulses remain well above ambient noise levels out to much longer distances (reviewed in Richardson et al. 1995; Gordon et al. 2004). However, studies done since the late 1990s of migrating humpback and migrating bowhead whales show reactions, including avoidance, that sometimes extend to greater distances than documented earlier. Therefore, it appears that behavioral disturbance can vary greatly depending on context, and not just received levels alone. Avoidance distances often exceed the distances at which boat-based observers can see whales, so

observations from the source vessel can be biased. Observations over broader areas may be needed to determine the range of potential effects of some large-source seismic surveys where effects on cetaceans may extend to considerable distances (Richardson et al. 1999; Moore and Angliss 2006). Longer-range observations, when required, can sometimes be obtained via systematic aerial surveys or aircraft-based observations of behavior (e.g., Richardson et al. 1986, 1999; Miller et al. 1999, 2005; Yazvenko et al. 2007a, 2007b) or by use of observers on one or more support vessels operating in coordination with the seismic vessel (e.g., Smultea et al. 2004; Johnson et al. 2007). However, the presence of other vessels near the source vessel can, at least at times, reduce sightability of cetaceans from the source vessel (Beland et al. 2009), thus complicating interpretation of sighting data.

Some baleen whales show considerable tolerance of seismic pulses. However, when the pulses are strong enough, avoidance or other behavioral changes become evident. Because the responses become less obvious with diminishing received sound level, it has been difficult to determine the maximum distance (or minimum received sound level) at which reactions to seismic activity become evident and, hence, how many whales are affected.

Studies of gray, bowhead, and humpback whales have determined that received levels of pulses in the 160–170 dB re 1 μ Pa (rms) range seem to cause obvious avoidance behavior in a substantial fraction of the animals exposed (McCauley et al. 1998, 1999, 2000). In many areas, seismic pulses diminish to these levels at distances ranging from 4 - 15 km from the source. A substantial proportion of the baleen whales within such distances may show avoidance or other strong disturbance reactions to the operating airgun array. Some extreme examples including migrating bowhead whales avoiding considerably larger distances (20 –

30 km) and lower received sound levels (120–130 dB re 1 μ Pa (rms)) when exposed to airguns from seismic surveys. Also, even in cases where there is no conspicuous avoidance or change in activity upon exposure to sound pulses from distant seismic operations, there are sometimes subtle changes in behavior (e.g., surfacing–respiration–dive cycles) that are only evident through detailed statistical analysis (e.g., Richardson et al. 1986; Gailey et al. 2007).

Data on short-term reactions by cetaceans to impulsive noises are not necessarily indicative of long-term or biologically significant effects. It is not known whether impulsive sounds affect reproductive rate or distribution and habitat use in subsequent days or years. However, gray whales have continued to migrate annually along the west coast of North America despite intermittent seismic exploration (and much ship traffic) in that area for decades (Appendix A in Malme et al. 1984; Richardson et al. 1995), and there has been a substantial increase in the population over recent decades (Allen and Angliss 2010). The western Pacific gray whale population did not seem affected by a seismic survey in its feeding ground during a prior year (Johnson et al. 2007). Similarly, bowhead whales have continued to travel to the eastern Beaufort Sea each summer despite seismic exploration in their summer and autumn range for many years (Richardson et al. 1987), and their numbers have increased notably (Allen and Angliss 2010). Bowheads also have been observed over periods of days or weeks in areas ensonified repeatedly by seismic pulses (Richardson et al. 1987; Harris et al. 2007). However, it is generally not known whether the same individual bowheads were involved in these repeated observations (within and between years) in strongly ensonified areas.

Odontocete: Relatively little systematic information is available about reactions of toothed whales to airgun pulses. A few studies similar to the more extensive baleen

whale/seismic pulse work summarized above have been reported for toothed whales. However, there are recent systematic data on sperm whales (e.g., Gordon et al. 2006; Madsen et al. 2006; Winsor and Mate 2006; Jochens et al. 2008; Miller et al. 2009) and beluga whales (e.g., Miller et al. 2005). There is also an increasing amount of information about responses of various odontocetes to seismic surveys based on monitoring studies (e.g., Stone 2003; Smultea et al. 2004; Moulton and Miller 2005; Holst et al. 2006; Stone and Tasker 2006; Potter et al. 2007; Hauser et al. 2008; Holst and Smultea 2008; Weir 2008; Barkaszi et al. 2009; Richardson et al. 2009).

Dolphins and porpoises are often seen by observers on active seismic vessels, occasionally at close distances (e.g., bow riding). Marine mammal monitoring data during seismic surveys often show that animal detection rates drop during the firing of seismic airguns, indicating that animals may be avoiding the vicinity of the seismic area (Smultea et al. 2004; Holst et al. 2006; Hauser et al. 2008; Holst and Smultea 2008; Richardson et al. 2009). Also, belugas summering in the Canadian Beaufort Sea showed larger-scale avoidance, tending to avoid waters out to 10 – 20 km from operating seismic vessels (Miller et al. 2005). In contrast, recent studies show little evidence of conspicuous reactions by sperm whales to airgun pulses, contrary to earlier indications (e.g., Gordon et al. 2006; Stone and Tasker 2006; Winsor and Mate 2006; Jochens et al. 2008), except the lower buzz (echolocation signals) rates that were detected during exposure of airgun pulses (Miller et al. 2009).

There are almost no specific data on responses of beaked whales to seismic surveys, but it is likely that most if not all species show strong avoidance. There is increasing evidence that some beaked whales may strand after exposure to strong noise from tactical

military mid-frequency sonars. Whether they ever do so in response to seismic survey noise is unknown. Northern bottlenose whales seem to continue to call when exposed to pulses from distant seismic vessels.

For delphinids, and possibly the Dall's porpoise, the available data suggest that a ≥ 170 dB re 1 μ Pa (rms) disturbance criterion (rather than ≥ 160 dB) would be appropriate. With a medium-to-large airgun array, received levels typically diminish to 170 dB within 1 – 4 km, whereas levels typically remain above 160 dB out to 4 – 15 km (e.g., Tolstoy et al. 2009). Reaction distances for delphinids are more consistent with the typical 170 dB re 1 μ Pa (rms) distances. Stone (2003) and Stone and Tasker (2006) reported that all small odontocetes (including killer whales) observed during seismic surveys in UK waters remained significantly further from the source during periods of shooting on surveys with large volume airgun arrays than during periods without airgun shooting.

Due to their relatively higher frequency hearing ranges when compared to mysticetes, odontocetes may have stronger responses to mid- and high-frequency sources such as sub-bottom profilers, side scan sonar, and echo sounders than mysticetes (Richardson et al. 1995; Southall et al. 2007).

Pinnipeds: Few studies of the reactions of pinnipeds to noise from open-water seismic exploration have been published (for review of the early literature, see Richardson et al. 1995). However, pinnipeds have been observed during a number of seismic monitoring studies. Monitoring in the Beaufort Sea during 1996 – 2002 provided a substantial amount of information on avoidance responses (or lack thereof) and associated behavior. Additional monitoring of that type has been done in the Beaufort and Chukchi Seas in 2006 – 2009. Pinnipeds exposed to seismic surveys have also been observed during seismic surveys along

the U.S. west coast. Also, there are data on the reactions of pinnipeds to various other related types of impulsive sounds.

Early observations provided considerable evidence that pinnipeds are often quite tolerant of strong pulsed sounds. During seismic exploration off Nova Scotia, gray seals exposed to noise from airguns and linear explosive charges reportedly did not react strongly (J. Parsons in Greene et al. 1985). An airgun caused an initial startle reaction among South African fur seals but was ineffective in scaring them away from fishing gear. Pinnipeds in both water and air sometimes tolerate strong noise pulses from non-explosive and explosive scaring devices, especially if attracted to the area for feeding or reproduction (Mate and Harvey 1987; Reeves et al. 1996). Thus, pinnipeds are expected to be rather tolerant of, or to habituate to, repeated underwater sounds from distant seismic sources, at least when the animals are strongly attracted to the area.

In summary, visual monitoring from seismic vessels has shown only slight (if any) avoidance of airguns by pinnipeds, and only slight (if any) changes in behavior. These studies show that many pinnipeds do not avoid the area within a few hundred meters of an operating airgun array. However, based on the studies with large sample size, or observations from a separate monitoring vessel, or radio telemetry, it is apparent that some phocid seals do show localized avoidance of operating airguns. The limited nature of this tendency for avoidance is a concern. It suggests that one cannot rely on pinnipeds to move away, or to move very far away, before received levels of sound from an approaching seismic survey vessel approach those that may cause hearing impairment.

(2) Masking

Masking occurs when noise and signals (that animal utilizes) overlap at both spectral

and temporal scales. Chronic exposure to elevated sound levels could cause masking at particular frequencies for marine mammals, which utilize sound for important biological functions. Masking can interfere with detection of acoustic signals used for orientation, communication, finding prey, and avoiding predators. Marine mammals that experience severe (high intensity and extended duration) acoustic masking could potentially suffer reduced fitness, which could lead to adverse effects on survival and reproduction.

For the airgun noise generated from the proposed marine seismic survey, these are low frequency (under 1 kHz) pulses with extremely short durations (in the scale of milliseconds). Lower frequency man-made noises are more likely to affect detection of communication calls and other potentially important natural sounds such as surf and prey noise. There is little concern regarding masking due to the brief duration of these pulses and relatively longer silence between airgun shots (9 – 12 seconds) near the noise source, however, at long distances (over tens of kilometers away) in deep water, due to multipath propagation and reverberation, the durations of airgun pulses can be “stretched” to seconds with long decays (Madsen et al. 2006; Clark and Gagnon 2006). Therefore it could affect communication signals used by low frequency mysticetes when they occur near the noise band and thus reduce the communication space of animals (e.g., Clark et al. 2009a, 2009b) and affect their vocal behavior (e.g., Foote et al. 2004; Holt et al. 2009). Further, in areas of shallow water, multipath propagation of airgun pulses could be more profound, thus affecting communication signals from marine mammals even at close distances. Average ambient noise in areas where received seismic noises are heard can be elevated. At long distances, however, the intensity of the noise is greatly reduced. Nevertheless, partial informational and energetic masking of different degrees could affect signal receiving in some marine

mammals within the ensonified areas. Additional research is needed to further address these effects.

Although masking effects of pulsed sounds on marine mammal calls and other natural sounds are expected to be limited, there are few specific studies on this. Some whales continue calling in the presence of seismic pulses and whale calls often can be heard between the seismic pulses (e.g., Richardson et al. 1986; McDonald et al. 1995; Greene et al. 1999a, 1999b; Niekirk et al. 2004; Smultea et al. 2004; Holst et al. 2005a, 2005b, 2006; Dunn and Hernandez 2009).

Among the odontocetes, there has been one report that sperm whales ceased calling when exposed to pulses from a very distant seismic ship (Bowles et al. 1994). However, more recent studies of sperm whales found that they continued calling in the presence of seismic pulses (Madsen et al. 2002; Tyack et al. 2003; Smultea et al. 2004; Holst et al. 2006; Jochens et al. 2008). Madsen et al. (2006) noted that airgun sounds would not be expected to mask sperm whale calls given the intermittent nature of airgun pulses. Dolphins and porpoises are also commonly heard calling while airguns are operating (Gordon et al. 2004; Smultea et al. 2004; Holst et al. 2005a, 2005b; Potter et al. 2007). Masking effects of seismic pulses are expected to be negligible in the case of the smaller odontocetes, given the intermittent nature of seismic pulses plus the fact that sounds important to them are predominantly at much higher frequencies than are the dominant components of airgun sounds.

Pinnipeds have best hearing sensitivity and/or produce most of their sounds at frequencies higher than the dominant components of airgun sound, but there is some overlap in the frequencies of the airgun pulses and the calls. However, the intermittent nature of

airgun pulses presumably reduces the potential for masking.

Marine mammals are thought to be able to compensate for masking by adjusting their acoustic behavior such as shifting call frequencies, and increasing call volume and vocalization rates, as discussed earlier (e.g., Miller et al. 2000; Parks et al. 2007; Di Iorio and Clark 2009; Parks et al. 2010); the biological significance of these modifications is still unknown.

(3) Hearing Impairment

Marine mammals exposed to high intensity sound repeatedly or for prolonged periods can experience hearing threshold shift (TS), which is the loss of hearing sensitivity at certain frequency ranges (Kastak et al. 1999; Schlundt et al. 2000; Finneran et al. 2002; 2005). TS can be permanent (PTS), in which case the loss of hearing sensitivity is unrecoverable, or temporary (TTS), in which case the animal's hearing threshold will recover over time (Southall et al. 2007). Marine mammals that experience TTS or PTS will have reduced sensitivity at the frequency band of the TS, which may affect their capability of communication, orientation, or prey detection. The degree of TS depends on the intensity of the received levels the animal is exposed to, and the frequency at which TS occurs depends on the frequency of the received noise. It has been shown that in most cases, TS occurs at the frequencies approximately one-octave above that of the received noise. Repeated noise exposure that leads to TTS could cause PTS. For transient sounds, the sound level necessary to cause TTS is inversely related to the duration of the sound.

TTS:

TTS is the mildest form of hearing impairment that can occur during exposure to a strong sound (Kryter 1985). While experiencing TTS, the hearing threshold rises and a

sound must be stronger in order to be heard. It is a temporary phenomenon, and (especially when mild) is not considered to represent physical damage or “injury” (Southall et al. 2007). Rather, the onset of TTS is an indicator that, if the animal is exposed to higher levels of that sound, physical damage is ultimately a possibility.

The magnitude of TTS depends on the level and duration of noise exposure, and to some degree on frequency, among other considerations (Kryter 1985; Richardson et al. 1995; Southall et al. 2007). For sound exposures at or somewhat above the TTS threshold, hearing sensitivity recovers rapidly after exposure to the noise ends. In terrestrial mammals, TTS can last from minutes or hours to (in cases of strong TTS) days. Only a few data have been obtained on sound levels and durations necessary to elicit mild TTS in marine mammals (none in mysticetes), and none of the published data concern TTS elicited by exposure to multiple pulses of sound during operational seismic surveys (Southall et al. 2007).

For toothed whales, experiments on a bottlenose dolphin (*Tursiops truncatus*) and beluga whale showed that exposure to a single watergun impulse at a received level of 207 kPa (or 30 psi) peak-to-peak (p-p), which is equivalent to 228 dB re 1 μ Pa (p-p), resulted in a 7 and 6 dB TTS in the beluga whale at 0.4 and 30 kHz, respectively. Thresholds returned to within 2 dB of the pre-exposure level within 4 minutes of the exposure (Finneran et al. 2002). No TTS was observed in the bottlenose dolphin.

Finneran et al. (2005) further examined the effects of tone duration on TTS in bottlenose dolphins. Bottlenose dolphins were exposed to 3 kHz tones (non-impulsive) for periods of 1, 2, 4 or 8 seconds (s), with hearing tested at 4.5 kHz. For 1-s exposures, TTS occurred with SELs of 197 dB, and for exposures >1 s, SEL >195 dB resulted in TTS (SEL is equivalent to energy flux, in dB re 1 μ Pa²-s). At an SEL of 195 dB, the mean TTS (4 min

after exposure) was 2.8 dB. Finneran et al. (2005) suggested that an SEL of 195 dB is the likely threshold for the onset of TTS in dolphins and belugas exposed to tones of durations 1 – 8 s (i.e., TTS onset occurs at a near-constant SEL, independent of exposure duration). That implies that, at least for non-impulsive tones, a doubling of exposure time results in a 3 dB lower TTS threshold.

However, the assumption that, in marine mammals, the occurrence and magnitude of TTS is a function of cumulative acoustic energy (SEL) is probably an oversimplification. Kastak et al. (2005) reported preliminary evidence from pinnipeds that, for prolonged non-impulse noise, higher SELs were required to elicit a given TTS if exposure duration was short than if it was longer, i.e., the results were not fully consistent with an equal-energy model to predict TTS onset. Mooney et al. (2009a) showed this in a bottlenose dolphin exposed to octave-band non-impulse noise ranging from 4 to 8 kHz at SPLs of 130 to 178 dB re 1 μ Pa for periods of 1.88 to 30 minutes (min). Higher SELs were required to induce a given TTS if exposure duration was short than if it was longer. Exposure of the aforementioned bottlenose dolphin to a sequence of brief sonar signals showed that, with those brief (but non-impulse) sounds, the received energy (SEL) necessary to elicit TTS was higher than was the case with exposure to the more prolonged octave-band noise (Mooney et al. 2009b). Those authors concluded that, when using (non-impulse) acoustic signals of duration ~ 0.5 s, SEL must be at least 210 – 214 dB re 1 μ Pa²-s to induce TTS in the bottlenose dolphin. The most recent studies conducted by Finneran et al. also support the notion that exposure duration has a more significant influence compared to SPL as the duration increases, and that TTS growth data are better represented as functions of SPL and duration rather than SEL alone (Finneran et al. 2010a, 2010b). In addition, Finneran et al.

(2010b) conclude that when animals are exposed to intermittent noises, there is recovery of hearing during the quiet intervals between exposures through the accumulation of TTS across multiple exposures. Such findings suggest that when exposed to multiple seismic pulses, partial hearing recovery also occurs during the seismic pulse intervals.

For baleen whales, there are no data, direct or indirect, on levels or properties of sound that are required to induce TTS. The frequencies to which baleen whales are most sensitive are lower than those to which odontocetes are most sensitive, and natural ambient noise levels at those low frequencies tend to be higher (Urlick 1983). As a result, auditory thresholds of baleen whales within their frequency band of best hearing are believed to be higher (less sensitive) than are those of odontocetes at their best frequencies (Clark and Ellison 2004). From this, it is suspected that received levels causing TTS onset may also be higher in baleen whales. However, no cases of TTS are expected given the small size of the airguns proposed to be used and the strong likelihood that baleen whales (especially migrating bowheads) would avoid the approaching airguns (or vessel) before being exposed to levels high enough for there to be any possibility of TTS.

In pinnipeds, TTS thresholds associated with exposure to brief pulses (single or multiple) of underwater sound have not been measured. Initial evidence from prolonged exposures suggested that some pinnipeds may incur TTS at somewhat lower received levels than do small odontocetes exposed for similar durations (Kastak *et al.* 1999; 2005). However, more recent indications are that TTS onset in the most sensitive pinniped species studied (harbor seal, which is closely related to the ringed seal) may occur at a similar SEL as in odontocetes (Kastak *et al.* 2004).

Most cetaceans show some degree of avoidance of seismic vessels operating an

airgun array (see above). It is unlikely that these cetaceans would be exposed to airgun pulses at a sufficiently high level for a sufficiently long period to cause more than mild TTS, given the relative movement of the vessel and the marine mammal. TTS would be more likely in any odontocetes that bow- or wake-ride or otherwise linger near the airguns. However, while bow- or wake-riding, odontocetes would be at the surface and thus not exposed to strong sound pulses given the pressure release and Lloyd Mirror effects at the surface. But if bow- or wake-riding animals were to dive intermittently near airguns, they would be exposed to strong sound pulses, possibly repeatedly.

If some cetaceans did incur mild or moderate TTS through exposure to airgun sounds in this manner, this would very likely be a temporary and reversible phenomenon. However, even a temporary reduction in hearing sensitivity could be deleterious in the event that, during that period of reduced sensitivity, a marine mammal needed its full hearing sensitivity to detect approaching predators, or for some other reason.

Some pinnipeds show avoidance reactions to airguns, but their avoidance reactions are generally not as strong or consistent as those of cetaceans. Pinnipeds occasionally seem to be attracted to operating seismic vessels. There are no specific data on TTS thresholds of pinnipeds exposed to single or multiple low-frequency pulses. However, given the indirect indications of a lower TTS threshold for the harbor seal than for odontocetes exposed to impulse sound (see above), it is possible that some pinnipeds close to a large airgun array could incur TTS.

NMFS currently typically includes mitigation requirements to ensure that cetaceans and pinnipeds are not exposed to pulsed underwater noise at received levels exceeding, respectively, 180 and 190 dB re 1 μ Pa (rms). The 180/190 dB acoustic criteria were taken

from recommendations by an expert panel of the High Energy Seismic Survey (HESS) Team that performed an assessment on noise impacts by seismic airguns to marine mammals in 1997, although the HESS Team recommended a 180-dB limit for pinnipeds in California (HESS 1999). The 180 and 190 dB re 1 μ Pa (rms) levels have not been considered to be the levels above which TTS might occur. Rather, they were the received levels above which, in the view of a panel of bioacoustics specialists convened by NMFS before TTS measurements for marine mammals started to become available, one could not be certain that there would be no injurious effects, auditory or otherwise, to marine mammals. As summarized above, data that are now available imply that TTS is unlikely to occur in various odontocetes (and probably mysticetes as well) unless they are exposed to a sequence of several airgun pulses stronger than 190 dB re 1 μ Pa (rms). On the other hand, for the harbor seal, harbor porpoise, and perhaps some other species, TTS may occur upon exposure to one or more airgun pulses whose received level equals the NMFS “do not exceed” value of 190 dB re 1 μ Pa (rms). That criterion corresponds to a single-pulse SEL of 175–180 dB re 1 μ Pa²-s in typical conditions, whereas TTS is suspected to be possible in harbor seals and harbor porpoises with a cumulative SEL of ~171 and ~164 dB re 1 μ Pa²-s, respectively.

It has been shown that most large whales and many smaller odontocetes (especially the harbor porpoise) show at least localized avoidance of ships and/or seismic operations. Even when avoidance is limited to the area within a few hundred meters of an airgun array, that should usually be sufficient to avoid TTS based on what is currently known about thresholds for TTS onset in cetaceans. In addition, ramping up airgun arrays, which is standard operational protocol for many seismic operators, may allow cetaceans near the airguns at the time of startup (if the sounds are aversive) to move away from the seismic

source and to avoid being exposed to the full acoustic output of the airgun array. Thus, most baleen whales likely will not be exposed to high levels of airgun sounds provided the ramp-up procedure is applied. Likewise, many odontocetes close to the trackline are likely to move away before the sounds from an approaching seismic vessel become sufficiently strong for there to be any potential for TTS or other hearing impairment. Hence, there is little potential for baleen whales or odontocetes that show avoidance of ships or airguns to be close enough to an airgun array to experience TTS. Nevertheless, even if marine mammals were to experience TTS, the magnitude of the TTS is expected to be mild and brief, only a few decibels for minutes.

PTS:

When PTS occurs, there is physical damage to the sound receptors in the ear. In some cases, there can be total or partial deafness, whereas in other cases, the animal has an impaired ability to hear sounds in specific frequency ranges (Kryter 1985). Physical damage to a mammal's hearing apparatus can occur if it is exposed to sound impulses that have very high peak pressures, especially if they have very short rise times. (Rise time is the interval required for sound pressure to increase from the baseline pressure to peak pressure.)

There is no specific evidence that exposure to pulses of airgun sound can cause PTS in any marine mammal, even with large arrays of airguns. However, given the likelihood that some mammals close to an airgun array might incur at least mild TTS (see above), there has been further speculation about the possibility that some individuals occurring very close to airguns might incur PTS (e.g., Richardson et al. 1995; Gedamke et al. 2008). Single or occasional occurrences of mild TTS are not indicative of permanent auditory damage, but repeated or (in some cases) single exposures to a level well above that causing TTS onset

might elicit PTS.

Relationships between TTS and PTS thresholds have not been studied in marine mammals, but are assumed to be similar to those in humans and other terrestrial mammals (Southall et al. 2007). Based on data from terrestrial mammals, a precautionary assumption is that the PTS threshold for impulse sounds (such as airgun pulses as received close to the source) is at least 6 dB higher than the TTS threshold on a peak-pressure basis, and probably >6 dB higher (Southall et al. 2007). The low-to-moderate levels of TTS that have been induced in captive odontocetes and pinnipeds during controlled studies of TTS have been confirmed to be temporary, with no measurable residual PTS (Kastak et al. 1999; Schlundt et al. 2000; Finneran et al. 2002; 2005; Nachtigall et al. 2003; 2004). However, very prolonged exposure to sound strong enough to elicit TTS, or shorter-term exposure to sound levels well above the TTS threshold, can cause PTS, at least in terrestrial mammals (Kryter 1985). In terrestrial mammals, the received sound level from a single non-impulsive sound exposure must be far above the TTS threshold for any risk of permanent hearing damage (Kryter 1994; Richardson et al. 1995; Southall et al. 2007). However, there is special concern about strong sounds whose pulses have very rapid rise times. In terrestrial mammals, there are situations when pulses with rapid rise times (e.g., from explosions) can result in PTS even though their peak levels are only a few dB higher than the level causing slight TTS. The rise time of airgun pulses is fast, but not as fast as that of an explosion.

Some factors that contribute to onset of PTS, at least in terrestrial mammals, are as follows:

- exposure to a single very intense sound,

- fast rise time from baseline to peak pressure,
- repetitive exposure to intense sounds that individually cause TTS but not PTS, and
- recurrent ear infections or (in captive animals) exposure to certain drugs.

Cavanagh (2000) reviewed the thresholds used to define TTS and PTS. Based on this review and SACLANT (1998), it is reasonable to assume that PTS might occur at a received sound level 20 dB or more above that inducing mild TTS. However, for PTS to occur at a received level only 20 dB above the TTS threshold, the animal probably would have to be exposed to a strong sound for an extended period, or to a strong sound with a rather rapid rise time.

More recently, Southall et al. (2007) estimated that received levels would need to exceed the TTS threshold by at least 15 dB, on an SEL basis, for there to be risk of PTS. Thus, for cetaceans exposed to a sequence of sound pulses, they estimate that the PTS threshold might be an M-weighted SEL (for the sequence of received pulses) of ~198 dB re 1 $\mu\text{Pa}^2\text{-s}$. Additional assumptions had to be made to derive a corresponding estimate for pinnipeds, as the only available data on TTS-thresholds in pinnipeds pertained to nonimpulse sound (see above). Southall et al. (2007) estimated that the PTS threshold could be a cumulative SEL of ~186 dB re 1 $\mu\text{Pa}^2\text{-s}$ in the case of a harbor seal exposed to impulse sound. The PTS threshold for the California sea lion and northern elephant seal would probably be higher given the higher TTS thresholds in those species. Southall et al. (2007) also note that, regardless of the SEL, there is concern about the possibility of PTS if a cetacean or pinniped received one or more pulses with peak pressure exceeding 230 or 218 dB re 1 μPa , respectively. Thus, PTS might be expected upon exposure of cetaceans to either

SEL ≥ 198 dB re $1 \mu\text{Pa}^2\text{-s}$ or peak pressure ≥ 230 dB re $1 \mu\text{Pa}$. Corresponding proposed dual criteria for pinnipeds (at least harbor seals) are ≥ 186 dB SEL and ≥ 218 dB peak pressure (Southall et al. 2007). These estimates are all first approximations, given the limited underlying data, assumptions, species differences, and evidence that the “equal energy” model may not be entirely correct.

Sound impulse duration, peak amplitude, rise time, number of pulses, and inter-pulse interval are the main factors thought to determine the onset and extent of PTS. Ketten (1994) has noted that the criteria for differentiating the sound pressure levels that result in PTS (or TTS) are location and species specific. PTS effects may also be influenced strongly by the health of the receiver’s ear.

As described above for TTS, in estimating the amount of sound energy required to elicit the onset of TTS (and PTS), it is assumed that the auditory effect of a given cumulative SEL from a series of pulses is the same as if that amount of sound energy were received as a single strong sound. There are no data from marine mammals concerning the occurrence or magnitude of a potential partial recovery effect between pulses. In deriving the estimates of PTS (and TTS) thresholds quoted here, Southall et al. (2007) made the precautionary assumption that no recovery would occur between pulses.

It is unlikely that an odontocete would remain close enough to a large airgun array for sufficiently long to incur PTS. There is some concern about bowriding odontocetes, but for animals at or near the surface, auditory effects are reduced by Lloyd’s mirror and surface release effects. The presence of the vessel between the airgun array and bow-riding odontocetes could also, in some but probably not all cases, reduce the levels received by bow-riding animals (e.g., Gabriele and Kipple 2009). The TTS (and thus PTS) thresholds of

baleen whales are unknown but, as an interim measure, assumed to be no lower than those of odontocetes. Also, baleen whales generally avoid the immediate area around operating seismic vessels, so it is unlikely that a baleen whale could incur PTS from exposure to airgun pulses. The TTS (and thus PTS) thresholds of some pinnipeds (e.g., harbor seal) as well as the harbor porpoise may be lower (Kastak et al. 2005; Southall et al. 2007; Lucke et al. 2009). If so, TTS and potentially PTS may extend to a somewhat greater distance for those animals. Again, Lloyd's mirror and surface release effects will ameliorate the effects for animals at or near the surface.

(4) Non-auditory Physical Effects

Non-auditory physical effects might occur in marine mammals exposed to strong underwater pulsed sound. Possible types of non-auditory physiological effects or injuries that theoretically might occur in mammals close to a strong sound source include neurological effects, bubble formation, and other types of organ or tissue damage. Some marine mammal species (i.e., beaked whales) may be especially susceptible to injury and/or stranding when exposed to intense sounds. However, there is no definitive evidence that any of these effects occur even for marine mammals in close proximity to large arrays of airguns, and beaked whales do not occur in the proposed project area. In addition, marine mammals that show behavioral avoidance of seismic vessels, including most baleen whales, some odontocetes (including belugas), and some pinnipeds, are especially unlikely to incur non-auditory impairment or other physical effects.

Therefore, it is unlikely that such effects would occur during SAE's proposed seismic surveys given the brief duration of exposure, the small sound sources, and the planned monitoring and mitigation measures described later in this document.

Additional non-auditory effects include elevated levels of stress response (Wright et al. 2007; Wright and Highfill 2007). Although not many studies have been done on noise-induced stress in marine mammals, extrapolation of information regarding stress responses in other species seems applicable because the responses are highly consistent among all species in which they have been examined to date (Wright et al. 2007). Therefore, it is reasonable to conclude that noise acts as a stressor to marine mammals. Furthermore, given that marine mammals will likely respond in a manner consistent with other species studied, repeated and prolonged exposures to stressors (including or induced by noise) could potentially be problematic for marine mammals of all ages. Wright et al. (2007) state that a range of issues may arise from an extended stress response including, but not limited to, suppression of reproduction (physiologically and behaviorally), accelerated aging and sickness-like symptoms. However, as mentioned above, SAE's proposed activity is not expected to result in these severe effects due to the nature of the potential sound exposure.

(5) Stranding and Mortality

Marine mammals close to underwater detonations can be killed or severely injured, and the auditory organs are especially susceptible to injury (Ketten et al. 1993; Ketten 1995). Airgun pulses are less energetic and their peak amplitudes have slower rise times, while stranding and mortality events would include other energy sources (acoustical or shock wave) far beyond just seismic airguns. To date, there is no evidence that serious injury, death, or stranding by marine mammals can occur from exposure to airgun pulses, even in the case of large airgun arrays.

However, in numerous past IHA notices for seismic surveys, commenters have referenced two stranding events allegedly associated with seismic activities, one off Baja

California and a second off Brazil. NMFS has addressed this concern several times, and, without new information, does not believe that this issue warrants further discussion. For information relevant to strandings of marine mammals, readers are encouraged to review NMFS' response to comments on this matter found in 69 FR 74906 (December 14, 2004), 71 FR 43112 (July 31, 2006), 71 FR 50027 (August 24, 2006), and 71 FR 49418 (August 23, 2006).

It should be noted that strandings related to sound exposure have not been recorded for marine mammal species in the Chukchi or Beaufort seas. NMFS notes that in the Beaufort and Chukchi seas, aerial surveys have been conducted by BOEM (previously MMS) and industry during periods of industrial activity (and by BOEM during times with no activity). No strandings or marine mammals in distress have been observed during these surveys and none have been reported by North Slope Borough inhabitants. In addition, there are very few instances that seismic surveys in general have been linked to marine mammal strandings, other than those mentioned above. As a result, NMFS does not expect any marine mammals will incur serious injury or mortality in the Arctic Ocean or strand as a result of the proposed marine survey.

Potential Effects of Sonar Signals

Industrial standard navigational sonars would be used during SAE's proposed 3D seismic surveys program for navigation safety. Source characteristics of the representative generic equipment are discussed in the "Description of Specific Activity" section above. In general, the potential effects of this equipment on marine mammals are similar to those from the airgun, except the magnitude of the impacts is expected to be much less due to the lower intensity, higher frequencies, and with downward narrow beam patterns. In some cases, due

to the fact that the operating frequencies of some of this equipment (e.g., Kongsberg EA600 with frequencies up to 200 kHz) are above the hearing ranges of marine mammals, they are not expected to have any impacts to marine mammals.

Vessel Sounds

In addition to the noise generated from seismic airguns and active sonar systems, two vessels would be involved in the operations, including a source vessel and a support vessel that provides marine mammal monitoring and logistic support. Sounds from boats and vessels have been reported extensively (Greene and Moore 1995; Blackwell and Greene 2002; 2005; 2006). Numerous measurements of underwater vessel sound have been performed in support of recent industry activity in the Chukchi and Beaufort Seas. Results of these measurements were reported in various 90-day and comprehensive reports since 2007 (e.g., Aerts et al. 2008; Hauser et al. 2008; Brueggeman 2009; Ireland et al. 2009; O'Neill and McCrodan 2011; Chorney et al. 2011; McPherson and Warner 2012). For example, Garner and Hannay (2009) estimated sound pressure levels of 100 dB at distances ranging from approximately 1.5 to 2.3 mi (2.4 to 3.7 km) from various types of barges. MacDonald et al. (2008) estimated higher underwater SPLs from the seismic vessel Gilavar of 120 dB at approximately 13 mi (21 km) from the source, although the sound level was only 150 dB at 85 ft (26 m) from the vessel. Compared to airgun pulses, underwater sound from vessels is generally at relatively low frequencies.

The primary sources of sounds from all vessel classes are propeller cavitation, propeller singing, and propulsion or other machinery. Propeller cavitation is usually the dominant noise source for vessels (Ross 1976). Propeller cavitation and singing are produced outside the hull, whereas propulsion or other machinery noise originates inside the

hull. There are additional sounds produced by vessel activity, such as pumps, generators, flow noise from water passing over the hull, and bubbles breaking in the wake. Source levels from various vessels would be empirically measured before the start of the seismic surveys.

Anticipated Effects on Habitat

The primary potential impacts to marine mammals and other marine species are associated with elevated sound levels produced by airguns and vessels operating in the area. However, other potential impacts to the surrounding habitat from physical disturbance are also possible.

With regard to fish as a prey source for cetaceans and pinnipeds, fish are known to hear and react to sounds and to use sound to communicate (Tavolga et al. 1981) and possibly avoid predators (Wilson and Dill 2002). Experiments have shown that fish can sense both the strength and direction of sound (Hawkins 1981). Primary factors determining whether a fish can sense a sound signal, and potentially react to it, are the frequency of the signal and the strength of the signal in relation to the natural background noise level.

The level of sound at which a fish will react or alter its behavior is usually well above the detection level. Fish have been found to react to sounds when the sound level increased to about 20 dB above the detection level of 120 dB (Ona 1988); however, the response threshold can depend on the time of year and the fish's physiological condition (Engas et al. 1993). In general, fish react more strongly to pulses of sound rather than non-pulse signals (such as noise from vessels) (Blaxter et al. 1981), and a quicker alarm response is elicited when the sound signal intensity rises rapidly compared to sound rising more slowly to the same level.

Investigations of fish behavior in relation to vessel noise (Olsen et al. 1983; Ona

1988; Ona and Godo 1990) have shown that fish react when the sound from the engines and propeller exceeds a certain level. Avoidance reactions have been observed in fish such as cod and herring when vessels approached close enough that received sound levels are 110 dB to 130 dB (Nakken 1992; Olsen 1979; Ona and Godo 1990; Ona and Toresen 1988).

However, other researchers have found that fish such as polar cod, herring, and capeline are often attracted to vessels (apparently by the noise) and swim toward the vessel (Rostad et al. 2006). Typical sound source levels of vessel noise in the audible range for fish are 150 dB to 170 dB (Richardson et al. 1995).

Further, during the seismic survey only a small fraction of the available habitat would be ensonified at any given time. Disturbance to fish species would be short-term and fish would return to their pre-disturbance behavior once the seismic activity ceases (McCauley et al. 2000a, 2000b; Santulli et al. 1999; Pearson et al. 1992). Thus, the proposed survey would have little, if any, impact on the abilities of marine mammals to feed in the area where seismic work is planned.

Some mysticetes, including bowhead whales, feed on concentrations of zooplankton. Some feeding bowhead whales may occur in the Alaskan Beaufort Sea in July and August, and others feed intermittently during their westward migration in September and October (Richardson and Thomson [eds.] 2002; Lowry et al. 2004). A reaction by zooplankton to a seismic impulse would only be relevant to whales if it caused concentrations of zooplankton to scatter. Pressure changes of sufficient magnitude to cause that type of reaction would probably occur only very close to the source. Impacts on zooplankton behavior are predicted to be negligible, and that would translate into negligible impacts on feeding mysticetes. Thus, the proposed activity is not expected to have any habitat-related effects on prey species

that could cause significant or long-term consequences for individual marine mammals or their populations.

Potential Impacts on Availability of Affected Species or Stock for Taking for Subsistence Uses

Subsistence hunting is an essential aspect of Inupiat Native life, especially in rural coastal villages. The Inupiat participate in subsistence hunting activities in and around the Beaufort Sea. The animals taken for subsistence provide a significant portion of the food that will last the community through the year. Marine mammals represent on the order of 60-80% of the total subsistence harvest. Along with the nourishment necessary for survival, the subsistence activities strengthen bonds within the culture, provide a means for educating the young, provide supplies for artistic expression, and allow for important celebratory events.

The proposed seismic activities will occur within the marine subsistence area used by the village of Nuiqsut. Nuiqsut was established in 1973 at a traditional location on the Colville River providing equal access to upland (e.g., caribou, Dall sheep) and marine (e.g., whales, seals, and eiders) resources (Brown 1979).

Potential Impacts to Subsistence Uses

NMFS has defined “unmitigable adverse impact” in 50 CFR 216.103 as: “...an impact resulting from the specified activity: (1) That is likely to reduce the availability of the species to a level insufficient for a harvest to meet subsistence needs by: (i) Causing the marine mammals to abandon or avoid hunting areas; (ii) Directly displacing subsistence users; or (iii) Placing physical barriers between the marine mammals and the subsistence hunters; and (2) That cannot be sufficiently mitigated by other measures to increase the availability of marine mammals to allow subsistence needs to be met.”

(1) Bowhead Whales

Ten primary coastal Alaskan villages deploy whaling crews during whale migrations. Around SAE's proposed project areas in the Beaufort Sea, the primary bowhead hunting villages that could be affected are Barrow and Nuiqsut.

Whaling crews in Barrow hunt in both the spring and the fall (Funk and Galginaitis 2005). The primary bowhead whale hunt in Barrow occurs during spring, while the fall hunt is used to meet the quota and seek strikes that can be transferred from other communities. In the spring, the whales are hunted along leads that occur when the pack ice starts deteriorating. This tends to occur between the first week of April through May in Barrow, well before the proposed 3D OBC seismic survey would be conducted. The survey will start after all the ice melts, which would occur around mid-July.

Although Nuiqsut is located 40 km (25 mi) inland, bowhead whales are still a major fall subsistence resource. Although bowhead whales have been harvested in the past all along the barrier islands, Cross Island is the site currently used as the fall whaling base as it includes cabins and equipment for butchering whales. However, whalers must travel about 160 km (100 mi) annually to reach the Cross Island whaling camp which is located over 110 direct km (70 mi) from Nuiqsut. Whaling activity usually begins in late August with the arrival of whales migrating from the Canadian Beaufort Sea, and may occur as late as early October depending on ice conditions and quota fulfillment. Most whaling occurs relatively near (<16 km; <10 mi) the island, largely to prevent meat spoilage that can occur with a longer tow back to Cross Island. Since 1993, Cross Island hunters have harvested one to four whales annually, averaging three.

Cross Island is located 70 km (44 mi) east of the eastern boundary of the seismic

survey box, while Barrow is located approximately 350 km (217 mi) west of the western boundary of the seismic survey box. At this far distance, seismic activities are unlikely to affect Barrow or Cross Island based whaling, especially if the seismic operations temporarily cease during the fall bowhead whale hunt.

(2) Beluga Whales

Belugas typically do not represent a large proportion of the subsistence harvests by weight in the communities of Nuiqsut and Barrow. Barrow residents hunt beluga in the spring (normally after the bowhead hunt) in leads between Point Barrow and Skull Cliffs in the Chukchi Sea primarily in April-June, and later in the summer (July-August) on both sides of the barrier island in Elson Lagoon / Beaufort Sea (MMS 2008), but harvest rates indicate the hunts are not frequent. Although Nuiqsut whalers may incidentally harvest beluga whales while hunting bowheads, these whales are rarely seen and are not actively pursued. Any harvest would occur most likely in association with Cross Island.

For the same reason discussed above, the great distances from Barrow and Cross Island to either of the boundaries of the seismic survey box prompt NMFS to preliminarily determine that the proposed seismic activities would not adversely affect subsistence beluga whale hunt.

(3) Seals

The potential seismic survey area is also used by Nuiqsut villagers for hunting seals. All three seal species – ringed, spotted, and bearded – are taken. Sealing begins in April and May when villagers hunt seals at breathing holes in Harrison Bay. In early June, hunting is concentrated at the mouth of the Colville River where ice breakup flooding results in the ice thinning and seals becoming more visible. Once the ice is clear of the Delta (late June),

hunters will hunt in open boats along the ice edge from Harrison Bay to Thetis Island in a route called “round the world”. Thetis Island is important as it provides a weather refuge and a base for hunting bearded seals. During the July and August ringed and spotted seals are hunted in the lower 65 km (40 mi) of the Colville River proper.

In terms of pounds, approximately one-third of the village of Nuiqsut’s annual subsistence harvest is marine mammals (fish and caribou dominate the rest), of which bowhead whales contribute by far the most (Fuller and George 1999). Seals contribute only 2 to 3 percent of annual subsistence harvest (Brower and Opie 1997, Brower and Hepa 1998, Fuller and George 1999). Fuller and George (1999) estimated that 46 seals were harvested in 1992. The more common ringed seals appear to dominate the harvest although the larger and thicker skinned bearded seals are probably preferred. Spotted seals occur in the Colville River Delta in small numbers, which is reflected in the harvest.

Available harvest records suggest that most seal harvest occurs in the months preceding the July start of seismic survey when waning ice conditions provide the best opportunity to approach and kill hauled out seals. Much of the late summer seal harvest occurs in the Colville River as the seals follow fish runs upstream. Still, open water seal hunting could occur coincident with the seismic surveys, especially bearded seal hunts based from Thetis Island. In general, however, given the relatively low contribution of seals to the Nuiqsut subsistence, and the greater opportunity to hunt seals earlier in the season, the seismic survey impact to seal hunting is likely remote. Impacts to seal populations in general are also very small.

As stated earlier, the proposed seismic survey would take place between July and October. The timing of the surveys activities would mostly avoid any spring hunting

activities in Beaufort Sea villages. In addition, the proposed seismic surveys would occur in areas great distances from the places where subsistence activities occur. Therefore, due to the time and spatial separation of SAE's proposed 3D seismic surveys and the subsistent harvest by the local communities, it is anticipated to have no effects on spring harvesting and little or no effects on the occasional summer harvest of beluga whale, subsistence seal hunts (ringed and spotted seals are primarily harvested in winter while bearded seals are hunted during July - September in the Beaufort Sea), or the fall bowhead hunt.

In addition, SAE has developed and proposes to implement a number of mitigation measures (described in the next section) which include a proposed Marine Mammal Monitoring and Mitigation Plan (4MP), employment of subsistence advisors in the villages, and implementation of a Communications Plan (with operation of Communication Centers). SAE has also prepared a Plan of Cooperation (POC) under 50 CFR 216.104 Article 12 of the MMPA that addresses potential impacts on subsistent seal hunting activities.

Finally, to ensure that there will be no conflict from SAE's proposed open-water seismic surveys to subsistence activities, SAE stated that it will maintain communications with subsistence communities via the communication centers (Com and Call Centers) and signed the Conflict Avoidance Agreement (CAA) with Alaska whaling communities.

Proposed Mitigation

In order to issue an incidental take authorization under Section 101(a)(5)(D) of the MMPA, NMFS must set forth the permissible methods of taking pursuant to such activity, and other means of effecting the least practicable adverse impact on such species or stock and its habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of such species or stock for taking for certain subsistence

uses.

For the proposed SAE open-water 3D OBC seismic surveys in the Beaufort Sea, SAE worked with NMFS and proposed the following mitigation measures to minimize the potential impacts to marine mammals in the project vicinity as a result of the marine seismic survey activities. The primary purpose of these mitigation measures is to detect marine mammals within, or about to enter designated exclusion zones and to initiate immediate shutdown or power down of the airgun(s), therefore it's very unlikely potential injury or TTS to marine mammals would occur, and Level B behavioral of marine mammals would be reduced to the lowest level practicable.

(1) Establishing Exclusion and Disturbance Zones

Under current NMFS guidelines, the "exclusion zone" for marine mammal exposure to impulse sources is customarily defined as the area within which received sound levels are ≥ 180 dB (rms) re 1 μ Pa for cetaceans and ≥ 190 dB (rms) re 1 μ Pa for pinnipeds. These safety criteria are based on an assumption that SPL received at levels lower than these will not injure these animals or impair their hearing abilities, but that at higher levels might have some such effects. Disturbance or behavioral effects to marine mammals from underwater sound may occur after exposure to sound at distances greater than the exclusion zones (Richardson et al. 1995). Currently, NMFS uses 160 dB (rms) re 1 μ Pa as the threshold for Level B behavioral harassment from impulses noise.

As discussed above, the acoustic propagation of the proposed 440-in³, 880-in³, and 1,760-in³ airgun arrays were predicted using JASCO's model provided in Aerts et al. (2008), corrected with the measured or manufacture's source levels. The resulting isopleths modeled

for the 190, 180, and 160 dB (rms) re 1 μ Pa exclusion zones and zones of influence are listed in Table 2.

These safety distances will be implemented at the commencement of 2013 airgun operations to establish marine mammal exclusion zones used for mitigation. SAE will conduct sound source measurements of the airgun array at the beginning of survey operations in 2013 to verify the size of the various marine mammal exclusion zones. The acoustic data will be analyzed as quickly as reasonably practicable in the field and used to verify and adjust the marine mammal exclusion zone distances. The mitigation measures to be implemented at the 190 and 180 dB (rms) sound levels will include power downs and shut downs as described below.

(2) Vessel Related Mitigation Measures,

This proposed mitigation measures apply to all vessels that are part of the Beaufort Sea seismic survey activities, including supporting vessels.

- Avoid concentrations or groups of whales by all vessels under the direction of SAE. Operators of vessels should, at all times, conduct their activities at the maximum distance possible from such concentrations of whales.
- Vessels in transit shall be operated at speeds necessary to ensure no physical contact with whales occurs. If any vessel approaches within 1.6 km (1 mi) of observed bowhead whales, except when providing emergency assistance to whalers or in other emergency situations, the vessel operator will take reasonable precautions to avoid potential interaction with the bowhead whales by taking one or more of the following actions, as appropriate:

- Reducing vessel speed to less than 5 knots within 300 yards (900 feet or 274 m) of the whale(s);
 - Steering around the whale(s) if possible;
 - Operating the vessel(s) in such a way as to avoid separating members of a group of whales from other members of the group;
 - Operating the vessel(s) to avoid causing a whale to make multiple changes in direction; and
 - Checking the waters immediately adjacent to the vessel(s) to ensure that no whales will be injured when the propellers are engaged.
- When weather conditions require, such as when visibility drops, adjust vessel speed accordingly to avoid the likelihood of injury to whales.

(3) Mitigation Measures for Airgun Operations

The primary role for airgun mitigation during the seismic surveys is to monitor marine mammals near the airgun array during all daylight airgun operations and during any nighttime start-up of the airguns. During the seismic surveys PSOs will monitor the pre-established exclusion zones for the presence of marine mammals. When marine mammals are observed within, or about to enter, designated safety zones, PSOs have the authority to call for immediate power down (or shutdown) of airgun operations as required by the situation. A summary of the procedures associated with each mitigation measure is provided below.

Ramp Up Procedure

A ramp up of an airgun array provides a gradual increase in sound levels, and involves a step-wise increase in the number and total volume of airguns firing until the full

volume is achieved. The purpose of a ramp up (or “soft start”) is to “warn” cetaceans and pinnipeds in the vicinity of the airguns and to provide time for them to leave the area and thus avoid any potential injury or impairment of their hearing abilities.

During the proposed open-water survey program, the seismic operator will ramp up the airgun arrays slowly. Full ramp ups (i.e., from a cold start after a shut down, when no airguns have been firing) will begin by firing a single airgun in the array (i.e., the mitigation airgun). A full ramp up, after a shut down, will not begin until there has been a minimum of 30 min of observation of the safety zone by PSOs to assure that no marine mammals are present. The entire exclusion zone must be visible during the 30-minute lead-in to a full ramp up. If the entire exclusion zone is not visible, then ramp up from a cold start cannot begin. If a marine mammal(s) is sighted within the safety zone during the 30-minute watch prior to ramp up, ramp up will be delayed until the marine mammal(s) is sighted outside of the exclusion zone or the animal(s) is not sighted for at least 15-30 minutes: 15 minutes for small odontocetes (harbor porpoise) and pinnipeds, or 30 minutes for baleen whales and large odontocetes (including beluga and killer whales and narwhal).

Use of a Small-Volume Airgun during Turns and Transits

Throughout the seismic survey, particularly during turning movements, and short transits, SAE will employ the use of the smallest volume airgun (i.e., “mitigation airgun”) to deter marine mammals from being within the immediate area of the seismic operations. The mitigation airgun would be operated at approximately one shot per minute and would not be operated for longer than three hours in duration (turns may last two to three hours for the proposed project).

During turns or brief transits (e.g., less than three hours) between seismic tracklines, one mitigation airgun will continue operating. The ramp-up procedure will still be followed when increasing the source levels from one airgun to the full airgun array. However, keeping one airgun firing will avoid the prohibition of a “cold start” during darkness or other periods of poor visibility. Through use of this approach, seismic surveys using the full array may resume without the 30 minute observation period of the full exclusion zone required for a “cold start”. PSOs will be on duty whenever the airguns are firing during daylight, during the 30 minute periods prior to ramp-ups.

Power-down and Shut Down Procedures

A power down is the immediate reduction in the number of operating energy sources from all firing to some smaller number (e.g., single mitigation airgun). A shut down is the immediate cessation of firing of all energy sources. The array will be immediately powered down whenever a marine mammal is sighted approaching close to or within the applicable safety zone of the full array, but is outside the applicable safety zone of the single mitigation source. If a marine mammal is sighted within or about to enter the applicable safety zone of the single mitigation airgun, the entire array will be shut down (i.e., no sources firing).

Poor visibility conditions

SAE plans to conduct 24-hour operations. PSOs will not be on duty during ongoing seismic operations during darkness, given the very limited effectiveness of visual observation at night (there will be no periods of darkness in the survey area until mid-August). The proposed provisions associated with operations at night or in periods of poor visibility include the following:

- If during foggy conditions, heavy snow or rain, or darkness (which may be encountered starting in late August), the full 180 dB exclusion zone is not visible, the airguns cannot commence a ramp-up procedure from a full shut-down.
- If one or more airguns have been operational before nightfall or before the onset of poor visibility conditions, they can remain operational throughout the night or poor visibility conditions. In this case ramp-up procedures can be initiated, even though the exclusion zone may not be visible, on the assumption that marine mammals will be alerted by the sounds from the single airgun and have moved away.

(4) Mitigation Measures for Subsistence Activities

Regulations at 50 CFR 216.104(a)(12) require IHA applicants for activities that take place in Arctic waters to provide a Plan of Cooperation (POC) or information that identifies what measures have been taken and/or will be taken to minimize adverse effects on the availability of marine mammals for subsistence purposes.

SAE has prepared a draft POC, which was developed based on identifying and evaluating any potential effects on seasonal abundance that is relied upon for subsistence use. For the proposed project SAE states that it will work closely with the North Slope Borough (NSB) and its partner Kuukpik Corporation, to identify subsistence communities and activities that may take place within or near the project area.

The scheduling of seismic activities will be discussed with representatives of all those concerned with the subsistence hunts. SAE presented the seismic project at the Alaska Eskimo Whaling Commission (AEWC) conference in December 2012 in Anchorage, Alaska.

SAE also had presented the project at the open-water meeting in March 2013 in Anchorage, Alaska.

In addition, SAE plans to hold additional meeting(s) the NSB and the villages of Nuiqsut, Barrow, and Kaktovik to discuss the proposed activities and monitoring and mitigation plans to minimize impacts. These discussions are scheduled for June / July and will include:

- a description of the proposed marine seismic survey, documentation of the crew's activities;
- documentation of consultation with local communities and tribal governments;
- project maps showing project boundaries;
- ongoing scheduling updates for information on the subsistence marine activities; and
- a plan for meetings and communication with post project subsistence communities.

A final POC that documents all meetings and consultations with community leaders and subsistence users will be submitted to NMFS.

In addition, SAE is planning to sign a CAA with the Alaska whaling communities to further ensure that its proposed open-water seismic survey activities in the Beaufort Sea will not have unmitigable impacts to subsistence activities. NMFS has included appropriate measures identified in the CAA in the IHA.

Mitigation Conclusions

NMFS has carefully evaluated the applicant's proposed mitigation measures and considered a range of other measures in the context of ensuring that NMFS prescribes the

means of effecting the least practicable impact on the affected marine mammal species and stocks and their habitat. Our evaluation of potential measures included consideration of the following factors in relation to one another:

- the manner in which, and the degree to which, the successful implementation of the measure is expected to minimize adverse impacts to marine mammals; and
- the practicability of the measure for applicant implementation.

Based on our evaluation of the applicant's proposed measures, as well as other measures considered by NMFS, NMFS has preliminarily determined that the proposed mitigation measures provide the means of effecting the least practicable impact on marine mammal species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance.

Proposed Monitoring and Reporting

In order to issue an ITA for an activity, Section 101(a)(5)(D) of the MMPA states that NMFS must set forth "requirements pertaining to the monitoring and reporting of such taking". The MMPA implementing regulations at 50 CFR 216.104(a)(13) indicate that requests for ITAs must include the suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species and of the level of taking or impacts on populations of marine mammals that are expected to be present in the proposed action area.

I. Proposed Monitoring Measures

The monitoring plan proposed by SAE is included in its IHA application and can be found in its Marine Mammal Monitoring and Mitigation Plan (4MP). The plan may be

modified or supplemented based on comments or new information received from the public during the public comment period. A summary of the primary components of the plan follows.

Monitoring will provide information on the numbers of marine mammals potentially affected by the exploration operations and facilitate real time mitigation to prevent injury of marine mammals by industrial sounds or activities. These goals will be accomplished in the Beaufort Sea during 2013 by conducting vessel-based monitoring from both source vessels and the mitigation vessel and an acoustic monitoring program using a bottom-mounted hydrophone array to document marine mammal presence and distribution in the vicinity of the survey area.

Visual monitoring by Protected Species Observers (PSOs) during active marine survey operations, and periods when these surveys are not occurring, will provide information on the numbers of marine mammals potentially affected by these activities and facilitate real time mitigation to prevent impacts to marine mammals by industrial sounds or operations. Vessel-based PSOs onboard the survey vessels and mitigation vessel will record the numbers and species of marine mammals observed in the area and any observable reaction of marine mammals to the survey activities in the Beaufort Sea.

Visual-based Protected Species Observers (PSOs)

The visual-based marine mammal monitoring will be implemented by a team of experienced PSOs, including both biologists and Inupiat personnel. PSOs will be stationed aboard the survey vessels and mitigation vessel through the duration of the project. The vessel-based marine mammal monitoring will provide the basis for real-time mitigation measures as discussed in the Proposed Mitigation section. In addition, monitoring results of

the vessel-based monitoring program will include the estimation of the number of “takes” as stipulated in the IHA.

(1) Protected Species Observers

Vessel-based monitoring for marine mammals will be done by trained PSOs throughout the period of survey activities. The observers will monitor the occurrence of marine mammals near the survey vessel during all daylight periods during operation, and during most daylight periods when operations are not occurring. PSO duties will include watching for and identifying marine mammals; recording their numbers, distances, and reactions to the survey operations; and documenting “take by harassment”.

A sufficient number of PSOs will be required onboard the survey vessel to meet the following criteria:

- 100% monitoring coverage during all periods of survey operations in daylight;
- maximum of 4 consecutive hours on watch per PSO; and
- maximum of 12 hours of watch time per day per PSO.

PSO teams will consist of Inupiat observers and experienced field biologists. Each vessel will have an experienced field crew leader to supervise the PSO team. The total number of PSOs may decrease later in the season as the duration of daylight decreases.

(2) Observer Qualifications and Training

Crew leaders and most PSOs will be individuals with experience as observers during recent seismic, site clearance and shallow hazards, and other monitoring projects in Alaska or other offshore areas in recent years.

Biologist-observers will have previous marine mammal observation experience, and field crew leaders will be highly experienced with previous vessel-based marine mammal

monitoring and mitigation projects. Resumes for those individuals will be provided to NMFS for review and acceptance of their qualifications. Inupiat observers will be experienced in the region and familiar with the marine mammals of the area. All observers will complete a NMFS-approved observer training course designed to familiarize individuals with monitoring and data collection procedures.

PSOs will complete a two or three-day training and refresher session on marine mammal monitoring, to be conducted shortly before the anticipated start of the 2013 open-water season. Any exceptions will have or receive equivalent experience or training. The training session(s) will be conducted by qualified marine mammalogists with extensive crew-leader experience during previous vessel-based seismic monitoring programs.

(3) Marine Mammal Observer Protocol

The PSOs will watch for marine mammals from the best available vantage point on the survey vessels, typically the bridge. The PSOs will scan systematically with the unaided eye and 7 x 50 reticle binoculars, supplemented with 20 x 60 image-stabilized binoculars or 25 x 150 binoculars, and night-vision equipment when needed. Personnel on the bridge will assist the marine mammal observer(s) in watching for marine mammals.

The observer(s) aboard the survey and mitigation vessels will give particular attention to the areas within the marine mammal exclusion zones around the source vessel. These zones are the maximum distances within which received levels may exceed 180 dB (rms) re 1 μ Pa (rms) for cetaceans, or 190 dB (rms) re 1 μ Pa for pinnipeds.

Distances to nearby marine mammals will be estimated with binoculars (7 x 50 binoculars) containing a reticle to measure the vertical angle of the line of sight to the animal relative to the horizon. Observers may use a laser rangefinder to test and improve their

abilities for visually estimating distances to objects in the water.

When a marine mammal is seen approaching or within the exclusion zone applicable to that species, the marine survey crew will be notified immediately so that mitigation measures called for in the applicable authorization(s) can be implemented.

Night-vision equipment (Generation 3 binocular image intensifiers or equivalent units) will be available for use when/if needed. Past experience with night-vision devices (NVDs) in the Beaufort Sea and elsewhere has indicated that NVDs are not nearly as effective as visual observation during daylight hours (e.g., Harris et al. 1997, 1998; Moulton and Lawson 2002).

Pinniped Surveys Before, During and After Seismic Surveys

SAE will also conduct a pinniped survey in the proposed seismic survey area before, during, and after the seismic surveys to provide a basis for determining whether ringed and bearded seals alter their habitat use patterns during the seismic survey. At the moment, SAE is in the process of developing a survey design using a combination of shipboard and aerial survey of the seismic survey block. This design will focus on resident ringed and spotted seals, spotted seal haul out use in the Colville River delta, and migrating and perhaps resident bearded seals. Both vessels and aircraft surveys will follow standard line transect methods.

Field Data-Recording

The PSOs aboard the vessels will maintain a digital log of seismic surveys, noting the date and time of all changes in seismic activity (ramp-up, power-down, changes in the active seismic source, shutdowns, etc.) and any corresponding changes in monitoring radii in a project-customized MysticetusTM observation software spreadsheet. In addition, PSOs will utilize this standardized format to record all marine mammal observations and mitigation

actions (seismic source power-downs, shut-downs, and ramp-ups). Information collected during marine mammal observations will include the following:

- Vessel speed, position, and activity
- Date, time, and location of each marine mammal sighting
- Number of marine mammals observed, and group size, sex, and age categories
- Observer's name and contact information
- Weather, visibility, and ice conditions at the time of observation
- Estimated distance of marine mammals at closest approach
- Activity at the time of observation, including possible attractants present
- Animal behavior
- Description of the encounter
- Duration of encounter
- Mitigation action taken

Data will preferentially be recorded directly into handheld computers or as a back-up, transferred from hard-copy data sheets into an electronic database. A system for quality control and verification of data will be facilitated by the pre-season training, supervision by the lead PSOs, in-season data checks. Computerized data validity checks will also be conducted, and the data will be managed in such a way that it is easily summarized during and after the field program and transferred into statistical, graphical, or other programs for further processing.

Passive Acoustic Monitoring

- (1) Sound Source Measurements

Prior to or at the beginning of the seismic survey, sound levels will be measured as a function of distance and direction from the proposed seismic source array (full array and reduced to a single mitigation airgun). Results of the acoustic characterization and SSV will be used to empirically refine the modeled distance estimates of the pre-season 190 dB, 180 dB, and 160 dB isopleths. The refined SSV exclusion zones will be used for the remainder of the seismic survey. Distance estimates for the 120 dB isopleth will also be modeled. The results of the SSV will be submitted to NMFS within five days after completing the measurements, followed by a report in 14 days. A more detailed report will be provided to NMFS as part of the 90-day report following completion of the acoustic program.

(2) Passive Acoustic Monitoring using Bottom-Mounted Hydrophones

SAE also plans to contract a hydroacoustic firm to conduct passive acoustic monitoring (PAM) with bottom-mounted hydrophones. The exact PAM methodology will depend on the firm selected, and the coordination that can be established with existing acoustical monitoring programs, but it will involve strategically placing bottom-anchored receivers near the survey area. The purpose will be to record seismic noise levels and marine mammal vocalizations before, during, and after the seismic survey. The PAM will provide additional information on marine mammal distribution and movement beyond what are observed by PSOs during the proposed seismic survey.

Monitoring Plan Peer Review

The MMPA requires that monitoring plans be independently peer reviewed “where the proposed activity may affect the availability of a species or stock for taking for subsistence uses” (16 U.S.C. 1371(a)(5)(D)(ii)(III)). Regarding this requirement, NMFS’ implementing regulations state, “Upon receipt of a complete monitoring plan, and at its

discretion, [NMFS] will either submit the plan to members of a peer review panel for review or within 60 days of receipt of the proposed monitoring plan, schedule a workshop to review the plan” (50 CFR 216.108(d)).

NMFS convened an independent peer review panel to review SAE’s mitigation and monitoring plan in its IHA application for taking marine mammals incidental to the proposed open-water marine surveys and equipment recovery and maintenance in the Beaufort Sea during 2013. The panel initially met on January 8 and 9, 2013, in Seattle, Washington. However, the panel decided that SAE’s IHA application and its 4MP did not contain adequate information for the panel to provide meaningful recommendations. After SAE revised its IHA application with additional information, on April 29, 2013, NMFS convened a new 2-person panel to conduct additional review of SAE’s 4MP. Both panel members provided their final reports to NMFS in May 2013. The reports from both panel members can be viewed at: <http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications>.

NMFS provided the panel with SAE’s monitoring and mitigation plan and asked the panel to address the following questions and issues for SAE’s plan:

- Will the applicant’s stated objectives effectively further the understanding of the impacts of their activities on marine mammals and otherwise accomplish the goals stated below? If not, how should the objectives be modified to better accomplish the goals above?
- Can the applicant achieve the stated objectives based on the methods described in the plan?
- Are there technical modifications to the proposed monitoring techniques and

methodologies proposed by the applicant that should be considered to better accomplish their stated objectives?

- Are there techniques not proposed by the applicant (i.e., additional monitoring techniques or methodologies) that should be considered for inclusion in the applicant's monitoring program to better accomplish their stated objectives?
- What is the best way for an applicant to present their data and results (formatting, metrics, graphics, etc.) in the required reports that are to be submitted to NMFS (i.e., 90-day report and comprehensive report)?

The peer review panel reports contain recommendations that the panel members felt were applicable to SAE's monitoring plans. The panel agrees that the objective of vessel-based monitoring to implement mitigation measures to prevent or limit Level A takes is appropriate. In addition, at the time the panel reviewed SAE's proposed marine mammal monitoring and mitigation plan, SAE only proposed vessel-based visual monitoring, and there was no pinniped survey being proposed to document pinniped habitat usage before, during, and after the seismic surveys.

Specific recommendations provided by the peer review panel to enhance marine mammal monitoring and information sharing include:

(1) passive acoustic monitoring for marine mammals in their study area before, during, and after operations to provide further understanding of the spatiotemporal distribution and acoustics of the marine mammal community in the area, and to provide a method of far-field monitoring;

(2) pinniped survey in the proposed seismic survey area before, during, and after the

seismic surveys to provide a basis for determining whether ringed and bearded seals alter their habitat use patterns during the seismic survey;

(3) consultation and coordination with other oil and gas companies and with federal, state, and borough agencies to ensure that they have the most up-to-date information and can take advantage of other monitoring efforts; and

(4) providing a database of the information collected, plus a number of summary analyses and graphics to help NMFS assess the potential impacts of their survey. Specific summaries/analyses/graphics would include:

- sound verification results including isopleths of sound pressure levels plotted geographically;
- a table or other summary of survey activities (i.e., did the survey proceed as planned);
- a table of sightings by time, location, species, and distance from the survey vessel;
- a geographic depiction of sightings for each species by area and month;
- a table and/or graphic summarizing behaviors observed by species;
- a table and/or graphic summarizing observed responses to the survey by species;
- a table of mitigation measures (e.g., powerdowns, shutdowns) taken by date, location, and species;
- a graphic of sightings by distance for each species and location;
- a table or graphic illustrating sightings during the survey versus sightings when the airguns were silent; and
- a summary of times when the survey was interrupted because of interactions with marine mammals.

NMFS worked with SAE on implementing the panel members' recommendations and suggestions. As a result, SAE agreed that all the above recommendations are reasonable and can be incorporated into its 4MP, and be included in the monitoring and mitigation measures.

II. Reporting Measures

Sound Source Verification Reports

A report on the preliminary results of the sound source verification measurements, including the measured 190, 180, and 160 dB (rms) radii of the airgun sources, would be submitted within 14 days after collection of those measurements at the start of the field season. This report will specify the distances of the exclusion zones that were adopted for the survey.

Technical Reports

The results of SAE's 2013 vessel-based monitoring, including estimates of "take" by harassment, would be presented in the "90-day" and Final Technical reports, if the IHA is issued. The Technical Reports should be submitted to NMFS within 90 days after the end of the seismic survey. The Technical Reports will include:

(a) summaries of monitoring effort (e.g., total hours, total distances, and marine mammal distribution through the study period, accounting for sea state and other factors affecting visibility and detectability of marine mammals);

(b) analyses of the effects of various factors influencing detectability of marine mammals (e.g., sea state, number of observers, and fog/glare);

(c) species composition, occurrence, and distribution of marine mammal sightings, including date, water depth, numbers, age/size/gender categories (if determinable), group sizes, and ice cover;

(d) To better assess impacts to marine mammals, data analysis should be separated into periods when a seismic airgun array (or a single mitigation airgun) is operating and when it is not. Final and comprehensive reports to NMFS should summarize and plot:

- Data for periods when a seismic array is active and when it is not; and
- The respective predicted received sound conditions over fairly large areas (tens of km) around operations;

(e) sighting rates of marine mammals during periods with and without airgun activities (and other variables that could affect detectability), such as:

- initial sighting distances versus airgun activity state;
- closest point of approach versus airgun activity state;
- observed behaviors and types of movements versus airgun activity state;
- numbers of sightings/individuals seen versus airgun activity state;
- distribution around the survey vessel versus airgun activity state; and
- estimates of take by harassment;

(f) Reported results from all hypothesis tests should include estimates of the associated statistical power when practicable;

(g) Estimate and report uncertainty in all take estimates. Uncertainty could be expressed by the presentation of confidence limits, a minimum-maximum, posterior probability distribution, etc.; the exact approach would be selected based on the sampling method and data available;

(h) The report should clearly compare authorized takes to the level of actual estimated takes; and

(i) Methodology used to estimate marine mammal takes and relative abundance on towed PAM.

Notification of Injured or Dead Marine Mammals

In addition, NMFS would require SAE to notify NMFS' Office of Protected Resources and NMFS' Stranding Network within 48 hours of sighting an injured or dead marine mammal in the vicinity of marine survey operations. SAE shall provide NMFS with the species or description of the animal(s), the condition of the animal(s) (including carcass condition if the animal is dead), location, time of first discovery, observed behaviors (if alive), and photo or video (if available).

In the event that an injured or dead marine mammal is found by SAE that is not in the vicinity of the proposed open-water marine survey program, SAE would report the same information as listed above as soon as operationally feasible to NMFS.

Estimated Take by Incidental Harassment

Except with respect to certain activities not pertinent here, the MMPA defines "harassment" as: any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment]. Only take by Level B behavioral harassment is anticipated as a result of the proposed open water marine survey program. Anticipated impacts to marine mammals are associated with noise propagation from the survey airgun(s) used in the seismic surveys.

The full suite of potential impacts to marine mammals was described in detail in the

“Potential Effects of the Specified Activity on Marine Mammals” section found earlier in this document. The potential effects of sound from the proposed open water marine survey programs might include one or more of the following: masking of natural sounds; behavioral disturbance; non-auditory physical effects; and, at least in theory, temporary or permanent hearing impairment (Richardson et al. 1995). As discussed earlier in this document, the most common impact will likely be from behavioral disturbance, including avoidance of the ensonified area or changes in speed, direction, and/or diving profile of the animal. For reasons discussed previously in this document, hearing impairment (TTS and PTS) is highly unlikely to occur based on the proposed mitigation and monitoring measures that would preclude marine mammals from being exposed to noise levels high enough to cause hearing impairment.

For impulse sounds, such as those produced by airgun(s) used in the 3D OBC seismic surveys, NMFS uses the 160 dB (rms) re 1 μ Pa isopleth to indicate the onset of Level B harassment. SAE provided calculations for the 160-dB isopleths produced by the proposed seismic surveys and then used those isopleths to estimate takes by harassment. NMFS used the calculations to make the necessary MMPA preliminary findings. SAE provided a full description of the methodology used to estimate takes by harassment in its IHA application, which is also provided in the following sections.

Basis for Estimating “Take by Harassment”

The estimate of the numbers of each species of marine mammals that could be “taken” by exposure to OBC seismic survey noise levels is determined by multiplying the maximum seasonal density of each species by the area that will be ensonified by greater than 160 dB (rms) re 1 μ Pa.

The areas ensonified by NMFS current Level B harassment exposure guideline levels was determined by assuming that the entire survey area is ensonified (given that the distance to the 160 dB isopleth during seismic survey is greater than the distance spacing between seismic source lines), plus a buffer area around the survey box corresponding to the distance to the 160 dB isopleth. The estimated distance to the 160 dB isopleth is 3 km (1.86 mi) based on a sound source of 236.55 dB (rms) re 1 μ Pa for the 1,760-in³ seismic array and JASCO's spreading model of $18 \log r + 0.0047$ estimated for similar Beaufort nearshore waters (BP Liberty) by Aerts et al. (2008). Placing a 3 km buffer around the 995 km² (384 mi²) seismic source area expands the ensonification (or Zone of Influence [ZOI]) area to approximately 1,476 km² (570 mi²).

Within the 1,476 km² ensonified area, 10 percent (148 km²) falls within the 0 to 1.5 m depth range, 25 percent (362 km²) falls within the 1.5 to 5 m depth range, 54 percent (793 km²) with the 5 to 15 m depth range, and 12 percent (177 km²) within waters greater than 15 m deep (bowhead migration corridor).

Marine Mammal Density Estimates

Density estimates were derived for bowhead whales, beluga whales, ringed seals, spotted seals, and bearded seals as described below. There are no available Beaufort Sea density estimates for gray whales, or extralimital species such as humpback whales, narwhals, and ribbon seals.

Bowhead Whale:

Summer density estimates for bowhead whales are based on surveys conducted by Brandon et al. (2011) in Harrison Bay during July and August of 2010. Their estimate, corrected for observer and availability bias (Thomas et al. 2002), was 0.004 whales per

square kilometer. A maximum density (0.016/km²) was derived by multiplying this value by 4 to account for variability.

Fall density estimates were based on Clarke and Ferguson's (2010) summarization of the 2000-2009 Bowhead Whale Aerial Survey Program (BWASP) conducted annually by the Bureau of Ocean and Energy Management (BOEM). The center of the potential survey box occurs between 150⁰ and 151⁰ longitude, and the survey area occurs in waters between 1 and

20 meters deep. Based on these same locations and water depths, LAMA Ecological and OASIS Environmental (2011) applied Thomas et al.'s (2002) bias correction factors to the number of whales and transect survey effort from September (96 animals, 9,933 km) and October (42 animals, 6,143 km) summarized in Clarke and Ferguson (2010) and calculated a September density of 0.1381 whales/km² and an October density of 0.0977 whales/km².

LAMA Ecological and OASIS Environmental (2011) also derived a mean density (0.1226 whales/km²) by averaging the September and October densities, and used the higher September value as the maximum density. Recognizing the validity of this approach, these same values are used in the calculations for this proposed IHA.

Beluga Whale:

The best data available for estimating summer beluga whale densities in the Alaskan Beaufort Sea is from Moore et al. (2000) based on aerial survey data collected 1982-1986.

The best fall data is from Clarke et al.'s (2011) compilation of beluga records collected

during the 2006-2008 BWASP surveys. Using these sighting records (summer 9; fall 7) and associated survey effort (summer 7,447 mi; fall 8,808 mi), average group size (summer 1.63, fall 2.9), and $f(0)$ and $g(0)$ values from Harwood et al. (1996), Shell Offshore, Inc. (2011), estimated summer and fall average density values for nearshore Beaufort Sea belugas. The estimates were multiplied by 4 to derive a maximum density.

Ringed Seal:

Surveys for ringed seals have been recently conducted in the Beaufort Sea by Kingsley (1986), Frost et al. (2002), Moulton and Lawson (2002), Green and Negri (2005), and Green et al. (2006, 2007). The shipboard monitoring surveys by Green and Negri (2005) and Green et al. (2006, 2007) were not systematically based, but are useful in estimating the general composition of pinnipeds in the Beaufort nearshore, including the Colville River Delta. Frost et al.'s aerial surveys were conducted during ice coverage and don't fully represent the summer and fall conditions under which the Beaufort surveys will occur. Moulton and Lawson (2002) conducted summer shipboard-based surveys for pinnipeds along the nearshore Beaufort Sea coast and developed seasonal average and maximum densities representative of SAE's Beaufort summer seismic project, while the Kingsley (1986) conducted surveys along the ice margin representing fall conditions.

Spotted Seal:

Green and Negri (2005) and Green et al. (2006, 2007) recorded pinnipeds during barging activity between West Dock and Cape Simpson, and found high numbers of ringed seal in Harrison Bay, and peaks in spotted seal numbers off the Colville River Delta where a haulout site is located. Approximately 5% of all phocid sightings recorded by Green and Negri (2005) and Green et al. (2006, 2007) were spotted seals, which provide a suitable

estimate of the proportion of ringed seals versus spotted seals in the Colville River Delta and Harrison Bay. Thus, the estimated densities of spotted seals in the seismic survey area were derived by multiplying the ringed seal densities from Moulton and Lawson (2002) and Kingsley (1986) by 0.05.

Bearded Seal:

Bearded seals were also recorded in Harrison Bay and the Colville River Delta by Green and Negri (2005) and Green et al. (2006, 2007), but at lower proportions to ringed seals than spotted seals. However, estimating bearded seal densities based on the proportion of bearded seals observed during the barge-based surveys results in density estimates that appear unrealistically low given density estimates from other studies, especially given that nearby Thetis Island is used as a base for annually hunting this seal (densities are seasonally high enough for focused hunting). For protective purposes, the bearded seal density values used in this application are derived from Stirling et al.'s (1982) observations that the proportion of eastern Beaufort Sea bearded seals is 5 percent that of ringed seals, similar as was done for spotted seals.

Exposure Calculation Methods

The estimated potential harassment take of local marine mammals by SAE's Beaufort seismic project was determined by multiplying the animal densities with the area ensonified by seismic-generated noise greater than 160 dB (rms) re 1 μ Pa that constitutes habitat for each respective species. For pinnipeds, which occupy all water depths, this includes the entire seismic survey area plus the additional 3 km (1.86 mi) buffer of noise exceeding 160 dB, or 1,476 km² (570 mi²).

Although the vast majority of bowhead whales migrate through the Beaufort sea in

waters greater than 15 m (50 ft) deep (Miller et al. 2002), feeding and migrating bowheads have been found in waters as shallow as 5 m (16 ft) (Clarke et al. 2011). Thus, the seismic survey area potentially inhabitable by bowhead whales is all waters greater than 5 m deep. This area, including the 3 km buffer, is 970 km² (375 mi²).

Beluga whales have been observed inside the barrier islands where they would have to traverse water depths as low as 1.8 meters, but these whales are unlikely to inhabit the shallowest water (<1.5 m deep) inside the barrier islands where stranding risk can be high. Therefore, the area of beluga habitat potentially ensonified (>160 dB) by the seismic operations is the waters greater than 1.5 m (5 ft) deep with the 3 km buffer, or approximately 1,332 km² (514 mi²).

Bowhead whale take estimates were calculated both for waters >5 and >15 m deep. Because the seismic surveys are expected to be operating 5 to 8 km south of the edge of the migration corridor by the time the fall migration commences, the fall exposure numbers (fall maximum of 24 whales) for waters greater than 15 m deep do not apply, and should be subtracted from the exposure estimate for waters greater than 5 m deep leaving an exposure estimate of 110 whales. However, even this fall maximum estimate is likely very protective given the fall density estimate is skewed by higher whale numbers in the deeper waters.

The take estimates also include species in which the estimated exposure is zero, but for which records for the Alaskan Beaufort Sea occur (i.e., humpback whale, gray whale, narwhal, and ribbon seal).

The take estimates also do not account for mitigation measures that will be implemented including shutting down operations during the fall bowhead hunt (thereby avoiding any noise exposure during the peak of fall bowhead whale migration) and

completing the seismic survey in waters greater than 15 m (50 ft) deep in August (thereby avoiding seismic survey within the bowhead whale migration corridor after the fall hunt).

These measures, coupled with ramping up of airguns, should reduce the estimated take from seismic survey operations.

Potential Number of “Take by Harassment”

As stated earlier, the estimates of potential Level B takes of marine mammals by noise exposure are based on a consideration of the number of marine mammals that might be present during operations in the Beaufort Sea and the anticipated area exposed to those sound pressure levels (SPLs) above 160 dB re 1 μ Pa for impulse sources (seismic airgun during 3D seismic surveys).

Table 3. Estimated take of marine mammals from the proposed SAE’s 3D OBC seismic survey in the Beaufort Sea during 2013 open-water season.

Species	Population	Estimated take	Abundance	Percent population
Bowhead whale	Bering-Chukchi-Beaufort	126	10,545	1.19%
Gray whale	Eastern North Pacific	2	19,126	0.01%
Humpback whale	Western North Pacific	2	939	0.21%
Beluga whale	Beaufort Sea	35	39,258	0.09%
Narwhal	Baffin Bay	2	45,000	0.004%
Ringed seal	Alaska	3,476	208,857	1.71%
Bearded seal	Alaska	179	250,000	0.07%
Spotted seal	Alaska	179	59,214	0.30%
Ribbon seal	Alaska	2	49,000	0.004%

Estimated Take Conclusions

Effects on marine mammals are generally expected to be restricted to avoidance of the area around the planned activities and short-term changes in behavior, falling within the MMPA definition of “Level B harassment”.

Cetaceans - The take calculation estimates suggest a total of 126 bowhead whales

may be exposed to sounds at or above 160 dB (rms) re 1 μ Pa (Table 3). This number is approximately 1.19% of the Bering–Chukchi–Beaufort (BCB) population of 10,545 assessed in 2001 (Allen and Angliss 2011) and is assuming to be increasing at an annual growth rate of 3.4% (Zeh and Punt 2005), which is supported by a 2004 population estimate of 12,631 by Koski et al. (2010). The total estimated number of beluga whales that may be exposed to sounds from the activities is 35 (Table 3). The small numbers of other whale species that may occur in the Beaufort Sea are unlikely to be present around the planned operations but chance encounters may occur. The few individuals would represent a very small proportion of their respective populations.

Pinnipeds - Ringed seal is by far the most abundant species expected to be encountered during the planned operations. The best estimate of the numbers of ringed seals exposed to sounds at the specified received levels during the planned activities is 3,476, which represent up to 1.71% of the Alaska population. Fewer individuals of other pinniped species are estimated to be exposed to sounds at Level B behavioral harassment level, also representing small proportions of their populations (Table 3).

Negligible Impact and Small Numbers Analysis and Preliminary Determination

As a preliminary matter, we typically include our negligible impact and small numbers analysis and determination under the same section heading of our Federal Register Notices. Despite co-locating these terms, we acknowledge that negligible impact and small numbers are distinct standards under the MMPA and treat them as such. The analysis presented below does not conflate the two standards; instead, each has been considered independently and we have applied the relevant factors to inform our negligible impact and small numbers determinations.

NMFS has defined “negligible impact” in 50 CFR 216.103 as “...an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival.” In making a negligible impact determination, NMFS considers a variety of factors, including but not limited to: (1) the number of anticipated mortalities; (2) the number and nature of anticipated injuries; (3) the number, nature, intensity, and duration of Level B harassment; and (4) the context in which the takes occur.

No injuries or mortalities are anticipated to occur as a result of SAE’s proposed 2013 open-water 3D OBC seismic survey in the Beaufort Sea, and none are proposed to be authorized. Additionally, animals in the area are not expected to incur hearing impairment (i.e., TTS or PTS) or non-auditory physiological effects. Takes will be limited to Level B behavioral harassment. Although it is possible that some individuals of marine mammals may be exposed to sounds from marine survey activities more than once, the expanse of these multi-exposures are expected to be less extensive since both the animals and the survey vessels will be moving constantly in and out of the survey areas.

Most of the bowhead whales encountered will likely show overt disturbance (avoidance) only if they receive airgun sounds with levels ≥ 160 dB re 1 μ Pa. Odontocete reactions to seismic airgun pulses are usually assumed to be limited to shorter distances from the airgun(s) than are those of mysticetes, probably in part because odontocete low-frequency hearing is assumed to be less sensitive than that of mysticetes. However, at least when in the Canadian Beaufort Sea in summer, belugas appear to be fairly responsive to seismic energy, with few being sighted within 6–12 mi (10–20 km) of seismic vessels during aerial surveys (Miller et al. 2005). Belugas will likely occur in small numbers in the Beaufort Sea during

the survey period and few will likely be affected by the survey activity.

As noted, elevated background noise level from the seismic airgun reverberant field could cause acoustic masking to marine mammals and reduce their communication space. However, even though the decay of the signal is extended, the fact that pulses are separated by approximately 8 to 10 seconds (or 4 to 5 seconds by two separate source vessels stationed 300 to 335 m (990 to 1,100 ft) apart) means that overall received levels at distance are expected to be much lower, thus resulting in less acoustic masking.

Taking into account the mitigation measures that are planned, effects on marine mammals are generally expected to be restricted to avoidance of a limited area around SAE's proposed open-water activities and short-term changes in behavior, falling within the MMPA definition of "Level B harassment". The many reported cases of apparent tolerance by cetaceans of seismic exploration, vessel traffic, and some other human activities show that co-existence is possible. Mitigation measures such as controlled vessel speed, dedicated marine mammal observers, non-pursuit, and shut downs or power downs when marine mammals are seen within defined ranges will further reduce short-term reactions and minimize any effects on hearing sensitivity. In all cases, the effects are expected to be short-term, with no lasting biological consequence.

Of the nine marine mammal species likely to occur in the proposed marine survey area, bowhead and humpback whales and ringed and bearded seals are listed as endangered or threatened under the ESA. These species are also designated as "depleted" under the MMPA. Despite these designations, the BCB stock of bowheads has been increasing at a rate of 3.4 percent annually for nearly a decade (Allen and Angliss 2010). Additionally, during the 2001 census, 121 calves were counted, which was the highest yet recorded. The

calf count provides corroborating evidence for a healthy and increasing population (Allen and Angliss 2010). The occurrence of fin and humpback whales in the proposed marine survey areas is considered very rare. There is no critical habitat designated in the U.S. Arctic for the bowhead and humpback whales. The Alaska stock of bearded seals, part of the Beringia distinct population segment (DPS), and the Arctic stock of ringed seals, have recently been listed by NMFS as threatened under the ESA. None of the other species that may occur in the project area are listed as threatened or endangered under the ESA or designated as depleted under the MMPA.

Potential impacts to marine mammal habitat were discussed previously in this document (see the “Anticipated Effects on Habitat” section). Although some disturbance is possible to food sources of marine mammals, the impacts are anticipated to be minor enough as to not affect rates of recruitment or survival of marine mammals in the area. Based on the vast size of the Arctic Ocean where feeding by marine mammals occurs versus the localized area of the marine survey activities, any missed feeding opportunities in the direct project area would be minor based on the fact that other feeding areas exist elsewhere.

The estimated takes proposed to be authorized represent 0.09% of the Beaufort Sea population of approximately 39,258 beluga whales, 0.01% of the Eastern North Pacific stock of approximately 19,126 gray whales, 1.19% of the Bering-Chukchi-Beaufort population of 10,545 bowhead whales, 0.21% of the Western North Pacific stock of approximately 938 humpback whales, and 0.004% of the Baffin Bay stock of approximately 45,000 narwhals. The take estimates presented for ringed, bearded, spotted, and ribbon seals represent 1.71, 0.07, 0.30, and 0.004% of U.S. Arctic stocks of each species, respectively. The mitigation and monitoring measures (described previously in this document) proposed for inclusion in

the IHA (if issued) are expected to reduce even further any potential disturbance to marine mammals.

In addition, no important feeding and reproductive areas are known in the vicinity of SAE's proposed seismic surveys at the time the proposed surveys are to take place. No critical habitat of ESA-listed marine mammal species occurs in the Beaufort Sea.

Based on the analysis contained herein of the likely effects of the specified activity on marine mammals and their habitat, and taking into consideration the implementation of the mitigation and monitoring measures, NMFS preliminarily finds that SAE's proposed 2013 open-water 3D OBC seismic surveys in the Beaufort Sea may result in the incidental take of small numbers of marine mammals, by Level B harassment only, and that the total taking from the marine surveys will have a negligible impact on the affected species or stocks.

Unmitigable Adverse Impact Analysis and Preliminary Determination

NMFS has preliminarily determined that SAE's proposed 2013 open-water 3D OBC seismic surveys in the Beaufort Sea will not have an unmitigable adverse impact on the availability of species or stocks for taking for subsistence uses. This preliminary determination is supported by information contained in this document and SAE's POC. SAE has adopted a spatial and temporal strategy for its Beaufort Sea open-water seismic surveys that should minimize impacts to subsistence hunters. Due to the timing of the project and the distance from the surrounding communities, it is anticipated to have no effects on spring harvesting and little or no effects on the occasional summer harvest of beluga whale, subsistence winter seal hunts, or the fall bowhead hunt.

In addition, based on the measures described in SAE's POC, the proposed mitigation and monitoring measures (described earlier in this document), and the project design itself,

NMFS has determined preliminarily that there will not be an unmitigable adverse impact on subsistence uses from SAE's 2013 open-water 3D OBC seismic surveys in the Beaufort Sea.

Proposed Incidental Harassment Authorization

This section contains a draft of the IHA itself. The wording contained in this section is proposed for inclusion in the IHA (if issued).

(1) This Authorization is valid from July 15, 2013, through October 31, 2013.

(2) This Authorization is valid only for activities associated with open-water 3D seismic surveys and related activities in the Beaufort Sea. The specific areas where SAE's surveys will be conducted are within the Beaufort Sea, Alaska, as shown in Figure 1-1 of SAE's IHA application.

(3)(a) The species authorized for incidental harassment takings, Level B harassment only, are: beluga whales (*Delphinapterus leucas*); narwhals (*Monodon monoceros*); bowhead whales (*Balaena mysticetus*); gray whales (*Eschrichtius robustus*); humpback whales (*Megaptera novaeangliae*); bearded seals (*Erignathus barbatus*); spotted seals (*Phoca largha*); ringed seals (*P. hispida*); and ribbon seals (*P. fasciata*).

(3)(b) The authorization for taking by harassment is limited to the following acoustic sources and from the following activities:

(i) 440-in³, 880-in³, and 1,760-in³ airgun arrays and other acoustic sources for 3D open-water seismic surveys; and

(ii) Vessel activities related to open-water seismic surveys listed in (i).

(3)(c) The taking of any marine mammal in a manner prohibited under this Authorization must be reported within 24 hours of the taking to the Alaska Regional Administrator (907-586-7221) or his designee in Anchorage (907-271-3023), National

Marine Fisheries Service (NMFS) and the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at (301) 427-8401, or his designee (301-427-8418).

(4) The holder of this Authorization must notify the Chief of the Permits and Conservation Division, Office of Protected Resources, at least 48 hours prior to the start of collecting seismic data (unless constrained by the date of issuance of this Authorization in which case notification shall be made as soon as possible).

(5) Prohibitions

(a) The taking, by incidental harassment only, is limited to the species listed under condition 3(a) above and by the numbers listed in Table 3. The taking by Level A harassment, injury or death of these species or the taking by harassment, injury or death of any other species of marine mammal is prohibited and may result in the modification, suspension, or revocation of this Authorization.

(b) The taking of any marine mammal is prohibited whenever the required source vessel protected species observers (PSOs), required by condition 7(a)(i), are not onboard in conformance with condition 7(a)(i) of this Authorization.

(6) Mitigation

(a) Establishing Exclusion and Disturbance Zones

(i) Establish and monitor with trained PSOs a preliminary exclusion zones for cetaceans surrounding the airgun array on the source vessel where the received level would be 180 dB (rms) re 1 μ Pa. For purposes of the field verification test, described in condition 7(e)(i), these radii are estimated to be 325, 494, and 842 m from the seismic source for the 440-in³, 880-in³, and 1,760-in³ airgun arrays, respectively.

(ii) Establish and monitor with trained PSOs a preliminary exclusion zones for

pinnipeds surrounding the airgun array on the source vessel where the received level would be 190 dB (rms) re 1 μ Pa. For purposes of the field verification test, described in condition 7(e)(i), these radii are estimated to be 126, 167, and 321 m from the seismic source for the 440-in³, 880-in³, and 1,760-in³ airgun arrays, respectively.

(iii) Establish a zone of influence (ZOIs) for cetaceans and pinnipeds surrounding the airgun array on the source vessel where the received level would be 160 dB (rms) re 1 μ Pa. For purposes of the field verification test described in condition 7(e)(i), these radii are estimated to be 1,330, 1,500, and 2,990 m from the seismic source for the 440-in³, 880-in³, and 1,760-in³ airgun arrays, respectively.

(iv) Immediately upon completion of data analysis of the field verification measurements required under condition 7(e)(i) below, the new 160-dB, 180-dB, and 190-dB marine mammal ZOIs and exclusion zones shall be established based on the sound source verification.

(b) Vessel Movement Mitigation:

(i) Avoid concentrations or groups of whales by all vessels under the direction of SAE. Operators of support vessels should, at all times, conduct their activities at the maximum distance possible from such concentrations of whales.

(ii) Vessels in transit shall be operated at speeds necessary to ensure no physical contact with whales occurs. If any vessel approaches within 1.6 km (1 mi) of observed bowhead whales, except when providing emergency assistance to whalers or in other emergency situations, the vessel operator will take reasonable precautions to avoid potential interaction with the bowhead whales by taking one or more of the following actions, as appropriate:

(A) Reducing vessel speed to less than 5 knots within 300 yards (900 feet or 274 m) of the whale(s);

(B) Steering around the whale(s) if possible;

(C) Operating the vessel(s) in such a way as to avoid separating members of a group of whales from other members of the group;

(D) Operating the vessel(s) to avoid causing a whale to make multiple changes in direction; and

(E) Checking the waters immediately adjacent to the vessel(s) to ensure that no whales will be injured when the propellers are engaged.

(iii) When weather conditions require, such as when visibility drops, adjust vessel speed accordingly to avoid the likelihood of injury to whales.

(c) Mitigation Measures for Airgun Operations

(i) Ramp-up:

(A) A ramp up, following a cold start, can be applied if the exclusion zone has been free of marine mammals for a consecutive 30-minute period. The entire exclusion zone must have been visible during these 30 minutes. If the entire exclusion zone is not visible, then ramp up from a cold start cannot begin.

(B) If a marine mammal(s) is sighted within the exclusion zone during the 30-minute watch prior to ramp up, ramp up will be delayed until the marine mammal(s) is sighted outside of the exclusion zone or the animal(s) is not sighted for at least 15-30 minutes: 15 minutes for pinnipeds, or 30 minutes for cetaceans.

(C) If, for any reason, electrical power to the airgun array has been discontinued for a period of 10 minutes or more, ramp-up procedures shall be implemented. Only if the PSO

watch has been suspended, a 30-minute clearance of the exclusion zone is required prior to commencing ramp-up. Discontinuation of airgun activity for less than 10 minutes does not require a ramp-up.

(D) The seismic operator and PSOs shall maintain records of the times when ramp-ups start and when the airgun arrays reach full power.

(ii) Power-down/Shutdown:

(A) The airgun array shall be immediately powered down whenever a marine mammal is sighted approaching close to or within the applicable exclusion zone of the full array, but is outside the applicable exclusion zone of the single mitigation airgun.

(B) If a marine mammal is already within the exclusion zone when first detected, the airguns shall be powered down immediately.

(C) Following a power-down, firing of the full airgun array shall not resume until the marine mammal has cleared the exclusion. The animal will be considered to have cleared the exclusion zone if it is visually observed to have left the exclusion zone of the full array, or has not been seen within the zone for 15 minutes (pinnipeds) or 30 minutes (cetaceans).

(D) If a marine mammal is sighted within or about to enter the 190 or 180 dB (rms) applicable exclusion zone of the single mitigation airgun, the airgun array shall be shutdown.

(E) Firing of the full airgun array or the mitigation gun shall not resume until the marine mammal has cleared the exclusion zone of the full array or mitigation gun, respectively. The animal will be considered to have cleared the exclusion zone as described above under ramp up procedures.

(iii) Poor Visibility Conditions:

(A) If during foggy conditions, heavy snow or rain, or darkness, the full 180 dB

exclusion zone is not visible, the airguns cannot commence a ramp-up procedure from a full shut-down.

(B) If one or more airguns have been operational before nightfall or before the onset of poor visibility conditions, they can remain operational throughout the night or poor visibility conditions. In this case ramp-up procedures can be initiated, even though the exclusion zone may not be visible, on the assumption that marine mammals will be alerted by the sounds from the single airgun and have moved away.

(iv) Use of a Small-Volume Airgun during Turns and Transits

(A) Throughout the seismic survey, particularly during turning movements, and short transits, SAE will employ the use of the smallest volume airgun (i.e., “mitigation airgun”) to deter marine mammals from being within the immediate area of the seismic operations. The mitigation airgun would be operated at approximately one shot per minute and would not be operated for longer than three hours in duration (turns may last two to three hours for the proposed project).

(B) During turns or brief transits (e.g., less than three hours) between seismic tracklines, one mitigation airgun will continue operating. The ramp-up procedure will still be followed when increasing the source levels from one airgun to the full airgun array. However, keeping one airgun firing will avoid the prohibition of a “cold start” during darkness or other periods of poor visibility. Through the use of this approach, seismic surveys using the full array may resume without the 30 minute observation period of the full exclusion zone required for a “cold start”. PSOs will be on duty whenever the airguns are firing during daylight, during the 30 minute periods prior to ramp-ups.

(d) Mitigation Measures for Subsistence Activities:

(i) For the purposes of reducing or eliminating conflicts between subsistence whaling activities and SAE's survey program, the holder of this Authorization will participate with other operators in the Communication and Call Centers (Com-Center) Program. The Com-Centers will be operated 24 hours/day during the 2013 fall subsistence bowhead whale hunt.

(ii) The appropriate Com-Center shall be notified if there is any significant change in plans.

(iii) Upon notification by a Com-Center operator of an at-sea emergency, the holder of this Authorization shall provide such assistance as necessary to prevent the loss of life, if conditions allow the holder of this Authorization to safely do so.

(7) Monitoring:

(a) Vessel-based Visual Monitoring:

(i) Vessel-based visual monitoring for marine mammals shall be conducted by NMFS-approved protected species observers (PSOs) throughout the period of survey activities.

(ii) PSOs shall be stationed aboard the seismic survey vessels and mitigation vessel through the duration of the surveys.

(iii) A sufficient number of PSOs shall be onboard the survey vessel to meet the following criteria:

(A) 100% monitoring coverage during all periods of survey operations in daylight;

(B) maximum of 4 consecutive hours on watch per PSO; and

(C) maximum of 12 hours of watch time per day per PSO.

(iv) The vessel-based marine mammal monitoring shall provide the basis for real-time mitigation measures as described in (6)(c) above.

(v) Results of the vessel-based marine mammal monitoring shall be used to calculate the estimation of the number of “takes” from the marine surveys and equipment recovery and maintenance program.

(b) Protected Species Observers and Training

(i) PSO teams shall consist of Inupiat observers and NMFS-approved field biologists.

(ii) Experienced field crew leaders shall supervise the PSO teams in the field. New PSOs shall be paired with experienced observers to avoid situations where lack of experience impairs the quality of observations.

(iii) Crew leaders and most other biologists serving as observers in 2013 shall be individuals with experience as observers during recent seismic or shallow hazards monitoring projects in Alaska, the Canadian Beaufort, or other offshore areas in recent years.

(iv) Resumes for PSO candidates shall be provided to NMFS for review and acceptance of their qualifications. Inupiat observers shall be experienced in the region and familiar with the marine mammals of the area.

(v) All observers shall complete a NMFS-approved observer training course designed to familiarize individuals with monitoring and data collection procedures. The training course shall be completed before the anticipated start of the 2013 open-water season. The training session(s) shall be conducted by qualified marine mammalogists with extensive crew-leader experience during previous vessel-based monitoring programs.

(vi) Training for both Alaska native PSOs and biologist PSOs shall be conducted at the same time in the same room. There shall not be separate training courses for the different PSOs.

(vii) Crew members should not be used as primary PSOs because they have other

duties and generally do not have the same level of expertise, experience, or training as PSOs, but they could be stationed on the fantail of the vessel to observe the near field, especially the area around the airgun array and implement a power down or shutdown if a marine mammal enters the safety zone (or exclusion zone).

(viii) If crew members are to be used as PSOs, they shall go through some basic training consistent with the functions they will be asked to perform. The best approach would be for crew members and PSOs to go through the same training together.

(ix) PSOs shall be trained using visual aids (e.g., videos, photos), to help them identify the species that they are likely to encounter in the conditions under which the animals will likely be seen.

(x) SAE shall train its PSOs to follow a scanning schedule that consistently distributes scanning effort according to the purpose and need for observations. All PSOs should follow the same schedule to ensure consistency in their scanning efforts.

(xi) PSOs shall be trained in documenting the behaviors of marine mammals. PSOs should simply record the primary behavioral state (i.e., traveling, socializing, feeding, resting, approaching or moving away from vessels) and relative location of the observed marine mammals.

(c) Marine Mammal Observation Protocol

(i) PSOs shall watch for marine mammals from the best available vantage point on the survey vessels, typically the bridge.

(ii) Observations by the PSOs on marine mammal presence and activity shall begin a minimum of 30 minutes prior to the estimated time that the seismic source is to be turned on and/or ramped-up.

(iii) PSOs shall scan systematically with the unaided eye and 7 x 50 reticle binoculars, supplemented with 20 x 60 image-stabilized binoculars or 25 x 150 binoculars, and night-vision equipment when needed.

(iv) Personnel on the bridge shall assist the marine mammal observer(s) in watching for marine mammals.

(v) PSOs aboard the marine survey vessel shall give particular attention to the areas within the marine mammal exclusion zones around the source vessel, as noted in (6)(a)(i) and (ii). They shall avoid the tendency to spend too much time evaluating animal behavior or entering data on forms, both of which detract from their primary purpose of monitoring the exclusion zone.

(vi) Monitoring shall consist of recording of the following information:

(A) the species, group size, age/size/sex categories (if determinable), the general behavioral activity, heading (if consistent), bearing and distance from seismic vessel, sighting cue, behavioral pace, and apparent reaction of all marine mammals seen near the seismic vessel and/or its airgun array (e.g., none, avoidance, approach, paralleling, etc);

(B) the time, location, heading, speed, and activity of the vessel (shooting or not), along with sea state, visibility, cloud cover and sun glare at (I) any time a marine mammal is sighted (including pinnipeds hauled out on barrier islands), (II) at the start and end of each watch, and (III) during a watch (whenever there is a change in one or more variable);

(C) the identification of all vessels that are visible within 5 km of the seismic vessel whenever a marine mammal is sighted and the time observed;

(D) any identifiable marine mammal behavioral response (sighting data should be collected in a manner that will not detract from the PSO's ability to detect marine mammals);

(E) any adjustments made to operating procedures; and

(F) visibility during observation periods so that total estimates of take can be corrected accordingly.

(vii) Distances to nearby marine mammals will be estimated with binoculars (7 x 50 binoculars) containing a reticle to measure the vertical angle of the line of sight to the animal relative to the horizon. Observers may use a laser rangefinder to test and improve their abilities for visually estimating distances to objects in the water.

(viii) PSOs shall understand the importance of classifying marine mammals as “unknown” or “unidentified” if they cannot identify the animals to species with confidence. In those cases, they shall note any information that might aid in the identification of the marine mammal sighted. For example, for an unidentified mysticete whale, the observers should record whether the animal had a dorsal fin.

(ix) Additional details about unidentified marine mammal sightings, such as “blow only”, mysticete with (or without) a dorsal fin, “seal splash”, etc., shall be recorded.

(x) When a marine mammal is seen approaching or within the exclusion zone applicable to that species, the marine survey crew shall be notified immediately so that mitigation measures described in (6) can be promptly implemented.

(xi) SAE shall use the best available technology to improve detection capability during periods of fog and other types of inclement weather. Such technology might include night-vision goggles or binoculars as well as other instruments that incorporate infrared technology.

(d) Field Data-Recording and Verification

(A) PSOs aboard the vessels shall maintain a digital log of seismic surveys, noting

the date and time of all changes in seismic activity (ramp-up, power-down, changes in the active seismic source, shutdowns, etc.) and any corresponding changes in monitoring radii in a software spreadsheet.

(B) PSOs shall utilize standardized format to record all marine mammal observations and mitigation actions (seismic source power-downs, shut-downs, and ramp-ups).

(C) Information collected during marine mammal observations shall include the following:

- (I) Vessel speed, position, and activity
- (II) Date, time, and location of each marine mammal sighting
- (III) Number of marine mammals observed, and group size, sex, and age categories
- (IV) Observer's name and contact information
- (V) Weather, visibility, and ice conditions at the time of observation
- (VI) Estimated distance of marine mammals at closest approach
- (VII) Activity at the time of observation, including possible attractants present
- (VIII) Animal behavior
- (IX) Description of the encounter
- (X) Duration of encounter
- (XI) Mitigation action taken

(D) Data shall be recorded directly into handheld computers or as a back-up, transferred from hard-copy data sheets into an electronic database.

(E) A system for quality control and verification of data shall be facilitated by the pre-season training, supervision by the lead PSOs, in-season data checks, and shall be built into the software.

(F) Computerized data validity checks shall also be conducted, and the data shall be managed in such a way that it is easily summarized during and after the field program and transferred into statistical, graphical, or other programs for further processing.

(e) Passive Acoustic Monitoring

(i) Sound Source Measurements: Using a hydrophone system, the holder of this Authorization is required to conduct sound source verification tests for seismic airgun array(s) and other marine survey equipment that are involved in the open-water seismic surveys.

(A) Sound source verification shall consist of distances where broadside and endfire directions at which broadband received levels reach 190, 180, 170, and 160 dB (rms) re 1 μ Pa for the airgun array(s). The configurations of airgun arrays shall include at least the full array and the operation of a single source that will be used during power downs.

(B) The test results shall be reported to NMFS within 5 days of completing the test.

(ii) Passive Acoustic Monitoring (PAM)

(A) SAE shall conduct passive acoustic monitoring using fixed hydrophone(s) to (I) collect information on the occurrence and distribution of marine mammals (including beluga whale, bowhead whale, walrus and other species) that may be available to subsistence hunters near villages located on the Beaufort Sea coast and to document their relative abundance, habitat use, and migratory patterns; and (II) measure the ambient soundscape throughout the Beaufort Sea coast and to record received levels of sounds from industry and other activities.

(f) Pinniped Surveys Before, During and After Seismic Surveys

(i) SAE shall conduct a pinniped survey in the proposed seismic survey area before,

during, and after the seismic surveys to provide a basis for determining whether ringed and bearded seals alter their habitat use patterns during the seismic survey.

(ii) The design of the pinniped survey will focus on resident ringed and spotted seals, spotted seal haul out use in the Colville River delta.

(g) SAE shall engage in consultation and coordination with other oil and gas companies and with federal, state, and borough agencies to ensure that they have the most up-to-date information and can take advantage of other monitoring efforts; and

(8) Data Analysis and Presentation in Reports:

(a) Estimation of potential takes or exposures shall be improved for times with low visibility (such as during fog or darkness) through interpolation or possibly using a probability approach. Those data could be used to interpolate possible takes during periods of restricted visibility.

(b) SAE shall provide a database of the information collected, plus a number of summary analyses and graphics to help NMFS assess the potential impacts of their survey.

Specific summaries/analyses/graphics would include:

(i) sound verification results including isopleths of sound pressure levels plotted geographically;

(ii) a table or other summary of survey activities (i.e., did the survey proceed as planned);

(iii) a table of sightings by time, location, species, and distance from the survey vessel;

(iv) a geographic depiction of sightings for each species by area and month;

(v) a table and/or graphic summarizing behaviors observed by species;

- (vi) a table and/or graphic summarizing observed responses to the survey by species;
- (vii) a table of mitigation measures (e.g., powerdowns, shutdowns) taken by date, location, and species;
- (viii) a graphic of sightings by distance for each species and location;
- (ix) a table or graphic illustrating sightings during the survey versus sightings when the airguns were silent; and
- (x) a summary of times when the survey was interrupted because of interactions with marine mammals.

(c) To help evaluate the effectiveness of PSOs and more effectively estimate take, if appropriate data are available, SAE shall perform analysis of sightability curves (detection functions) for distance-based analyses.

(d) SAE shall collaborate with other organizations operating in the Beaufort Sea and share visual and acoustic data to improve understanding of impacts from single and multiple operations and efficacy of mitigation measures.

(9) Reporting:

(a) Sound Source Verification Report: A report on the preliminary results of the sound source verification measurements, including the measured 190, 180, and 160 dB (rms) radii of the airgun sources and other acoustic survey equipment, shall be submitted within 14 days after collection of those measurements at the start of the field season. This report will specify the distances of the exclusion zones that were adopted for the survey.

(b) Throughout the survey program, PSOs shall prepare a report each day or at such other intervals, summarizing the recent results of the monitoring program. The reports shall summarize the species and numbers of marine mammals sighted. These reports shall be

provided to NMFS.

(c) Seismic Vessel Monitoring Program: A draft report will be submitted to the Director, Office of Protected Resources, NMFS, within 90 days after the end of SAE's 2013 open-water seismic surveys in the Beaufort Sea. The report will describe in detail:

(i) summaries of monitoring effort (e.g., total hours, total distances, and marine mammal distribution through the study period, accounting for sea state and other factors affecting visibility and detectability of marine mammals);

(ii) analyses of the effects of various factors influencing detectability of marine mammals (e.g., sea state, number of observers, and fog/glare);

(iii) species composition, occurrence, and distribution of marine mammal sightings, including date, water depth, numbers, age/size/gender categories (if determinable), group sizes, and ice cover;

(iv) to better assess impacts to marine mammals, data analysis should be separated into periods when an airgun array (or a single airgun) is operating and when it is not. Final and comprehensive reports to NMFS should summarize and plot: (A) Data for periods when a seismic array is active and when it is not; and (B) The respective predicted received sound conditions over fairly large areas (tens of km) around operations.

(v) sighting rates of marine mammals during periods with and without airgun activities (and other variables that could affect detectability), such as: (A) initial sighting distances versus airgun activity state; (B) closest point of approach versus airgun activity state; (C) observed behaviors and types of movements versus airgun activity state; (D) numbers of sightings/individuals seen versus airgun activity state; (E) distribution around the survey vessel versus airgun activity state; and (F) estimates of take by harassment.

(vi) reported results from all hypothesis tests should include estimates of the associated statistical power when practicable.

(vii) estimate and report uncertainty in all take estimates. Uncertainty could be expressed by the presentation of confidence limits, a minimum-maximum, posterior probability distribution, etc.; the exact approach would be selected based on the sampling method and data available.

(viii) The report should clearly compare authorized takes to the level of actual estimated takes.

(d) The draft report shall be subject to review and comment by NMFS. Any recommendations made by NMFS must be addressed in the final report prior to acceptance by NMFS. The draft report will be considered the final report for this activity under this Authorization if NMFS has not provided comments and recommendations within 90 days of receipt of the draft report.

(10) (a) In the unanticipated event that survey operations clearly cause the take of a marine mammal in a manner prohibited by this Authorization, such as an injury (Level A harassment), serious injury or mortality (e.g., ship-strike, gear interaction, and/or entanglement), SAE shall immediately cease survey operations and immediately report the incident to the Supervisor of the Incidental Take Program, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401 and/or by email to Jolie.Harrison@noaa.gov and Shane.Guan@noaa.gov and the Alaska Regional Stranding Coordinators (Aleria.Jensen@noaa.gov and Barbara.Mahoney@noaa.gov). The report must include the following information:

(i) time, date, and location (latitude/longitude) of the incident;

- (ii) the name and type of vessel involved;
- (iii) the vessel's speed during and leading up to the incident;
- (iv) description of the incident;
- (v) status of all sound source use in the 24 hours preceding the incident;
- (vi) water depth;
- (vii) environmental conditions (e.g., wind speed and direction, Beaufort sea state, cloud cover, and visibility);
- (viii) description of marine mammal observations in the 24 hours preceding the incident;
- (ix) species identification or description of the animal(s) involved;
- (x) the fate of the animal(s); and
- (xi) photographs or video footage of the animal (if equipment is available).

Activities shall not resume until NMFS is able to review the circumstances of the prohibited take. NMFS shall work with SAE to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. SAE may not resume their activities until notified by NMFS via letter, email, or telephone.

(b) In the event that SAE discovers an injured or dead marine mammal, and the lead PSO determines that the cause of the injury or death is unknown and the death is relatively recent (i.e., in less than a moderate state of decomposition as described in the next paragraph), SAE will immediately report the incident to the Supervisor of the Incidental Take Program, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401, and/or by email to Jolie.Harrison@noaa.gov and Shane.Guan@noaa.gov and the NMFS Alaska Stranding Hotline (1-877-925-7773) and/or by email to the Alaska Regional

Stranding Coordinators (Aleria.Jensen@noaa.gov and Barabara.Mahoney@noaa.gov). The report must include the same information identified in Condition 10(a) above. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with SAE to determine whether modifications in the activities are appropriate.

(c). In the event that SAE discovers an injured or dead marine mammal, and the lead PSO determines that the injury or death is not associated with or related to the activities authorized in Condition 3 of this Authorization (e.g., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), SAE shall report the incident to the Supervisor of the Incidental Take Program, Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401, and/or by email to Jolie.Harrison@noaa.gov and Shane.Guan@noaa.gov and the NMFS Alaska Stranding Hotline (1-877-925-7773) and/or by email to the Alaska Regional Stranding Coordinators (Aleria.Jensen@noaa.gov and Barbara.Mahoney@noaa.gov), within 24 hours of the discovery. SAE shall provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS and the Marine Mammal Stranding Network. SAE can continue its operations under such a case.

(11) Activities related to the monitoring described in this Authorization do not require a separate scientific research permit issued under section 104 of the Marine Mammal Protection Act.

(12) The Plan of Cooperation outlining the steps that will be taken to cooperate and communicate with the native communities to ensure the availability of marine mammals for subsistence uses, must be implemented.

(13) This Authorization may be modified, suspended or withdrawn if the holder fails

to abide by the conditions prescribed herein or if the authorized taking is having more than a negligible impact on the species or stock of affected marine mammals, or if there is an unmitigable adverse impact on the availability of such species or stocks for subsistence uses.

(14) A copy of this Authorization and the Incidental Take Statement must be in the possession of each seismic vessel operator taking marine mammals under the authority of this Incidental Harassment Authorization.

(15) SAE is required to comply with the Terms and Conditions of the Incidental Take Statement corresponding to NMFS' Biological Opinion.

Endangered Species Act (ESA)

The bowhead and humpback whales and ringed and bearded seals are the only marine mammal species currently listed as endangered or threatened under the ESA that could occur during SAE's proposed seismic surveys during the Arctic open-water season. NMFS' Permits and Conservation Division has initiated consultation with NMFS' Protected Resources Division under section 7 of the ESA on the issuance of an IHA to SAE under section 101(a)(5)(D) of the MMPA for this activity. Consultation will be concluded prior to a determination on the issuance of an IHA.

National Environmental Policy Act (NEPA)

NMFS is currently preparing an Environmental Assessment, pursuant to NEPA, to determine whether or not this proposed activity may have a significant effect on the human environment. This analysis will be completed prior to the issuance or denial of the IHA.

Proposed Authorization

As a result of these preliminary determinations, NMFS proposes to authorize the take of marine mammals incidental to SAE's 2013 open-water 3D OBC seismic surveys in the Alaskan Beaufort Sea, provided the previously mentioned mitigation, monitoring, and reporting requirements are incorporated.

Dated: June 10, 2013.

Donna S. Wieting,
Director,
Office of Protected Resources,
National Marine Fisheries Service.

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