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

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648–XC563

Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to Marine Seismic Survey in the Chukchi 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 TGS–NOPEC Geophysical Company ASA (TGS) for an Incidental Harassment Authorization (IHA) to take marine mammals, by harassment only, incidental to a marine 2-dimensional (2D) seismic survey program in the Chukchi 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 TGS to take, by Level B harassment, 12 species of marine mammals during the specified activity.

DATES: Comments and information must be received no later than July 12, 2013.

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 email comments sent to addresses other than the one provided here. Comments sent via email, 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 3, 2012, NMFS received an application from TGS requesting an authorization for the harassment of small numbers of marine mammals incidental to conducting an open-water 2D seismic survey in the Chukchi Sea off Alaska. After addressing comments from NMFS, TGS modified its application and submitted a revised application on April 1, 2013, and a revised marine mammal monitoring and mitigation plan on April 15, 2013, with additional clarification on May 7, 2013. TGS' proposed activities discussed here are based on its April 1, 2013, IHA application and April 15, 2013, marine mammal monitoring and mitigation measures.

Description of the Specified Activity

TGS proposes to conduct approximately 9,600 km of marine 2D seismic surveys along pre-determined lines in U.S. waters and international waters of the Chukchi Sea (Figure 1 of TGS' IHA application) during the 2013 open water season. The purpose of the proposed seismic program is to gather geophysical data using a 3,280 in^3 seismic source array and an 8,100-m long hydrophone solid streamer towed by the seismic vessel. Results of the 2D seismic program would be used to identify and map potential hydrocarbon-bearing formations and the geologic structures that surround them.

TGS plans to enter the U.S. Chukchi Sea sometime between 15 July and 5 August, 2013. Approximately 35 days of seismic operations are expected to occur over a period of about 45–60 days in U.S. Chukchi Sea. In addition, up to 33 days of seismic operations may occur in international waters (depending on ice and weather conditions). Seismic operations are proposed to occur along pre-determined track lines at speeds of about four to five knots. Seismic operations would be conducted up to 24 hours per day as possible except as potentially needed for shut-down mitigation for marine mammals. The full 3,280 in^3 airgun array would only be firing during seismic acquisition operations on and near the end and start of survey lines; during turns and transits between seismic lines, a single ''mitigation'' airgun (60 in^3 or smaller) is proposed to be operated.

Two vessels would be used during the survey: (1) A seismic operations vessel that would tow the seismic source array hydrophone solid streamer, and (2) a smaller vessel that will be used to search for marine mammals and scout

for ice and other navigation hazards ahead of the seismic vessel. In the event of an emergency, the scout vessel may be used to support the seismic vessel. In this extraordinary circumstance, all seismic activity will cease since the scout vessel will no longer be devoted to monitoring the exclusion zones.

The seismic vessel will tow a compressed-air seismic source array of 28 Bolt 1900 LLXT airguns with a total discharge volume of 3,280 in^3. The airguns range in volume from 40 in^3 to 300 in^3 and are arranged in a geometric lay-out of three sub-arrays that will be towed approximately 200 m behind the vessel at a depth of 6 m. The seismic source would discharge every 25 m (82 ft) or approximately every 10 seconds. Additional details regarding seismic acquisition parameters are provided in TGS' IHA application. To ascertain whether the seismic source array is operating correctly, the full volume will be enabled for 1 km from the start of every line (i.e., a run in). To ensure full fold data acquisition the vessel will require a 4 km run out at the conclusion of each line. TGS states that gravity and magnetic data will also be passively acquired during the survey by measuring gravity and magnetic variations while traversing the lines (no acoustics are involved with these methods).

The acoustic source level of the proposed 3,280 in^3 seismic source array was predicted using JASCO's airgun array source model (AASM) based on data collected from three sites chosen in the project area by JASCO. Water depths at the three sites were 17, 40, and 100 m. JASCO applied its Marine Operations Noise Model (MONM) to estimate acoustic propagation of the proposed seismic source array and the associated distances to the 190, 180 and 160 dB (rms) re 1 µPa isopleths. The resulting isopleths modeled for the 180 and 190 dB (rms) re 1 µPa exclusion zone distances for cetaceans and pinnipeds, respectively, differed with the three water depths. An additional 10 percent distance buffer was added by JASCO to these originally modeled distances to provide larger, more protective exclusion zone radii distances that will be adhered to during the project (Table 1).

The estimated distances to the 190, 180 and 160 dB re 1µPa (rms) isopleths for the single 60 in3 airgun (the largest single airgun that would be used as a ''mitigation'' gun) were measured by JASCO during a monitoring sound source verification (SSV) study conducted for Statoil in 2010 in the Chukchi Sea during the open water season of 2010 (Blees *et al.* 2010). Results indicated that the distance to the 190 dB isopleth was 13 m, the 180 dB isopleth distance was 68 m, and the 160 dB isopleth distance was 1,500 m (all dB (rms) re 1 µPa).

TABLE 1—MODELED DISTANCES IN (METERS) TO RECEIVED SOUND LEVELS FOR THE TGS' 3,280 IN^3 AIRGUN ARRAY IN WATERS WITH THREE DIFFERENT DEPTHS IN THE CHUKCHI SEA

Water depths (m)	Received sound level (dB re 1 µPa rms)		
	190	180	160
17–40	930	2,200	8,500
40–100	920	2,500	9,900
>100	430	2,400	15,000

Both vessels would use industry-standard echosounder/fathometer instruments to continuously monitor water depth for navigation purposes while underway. These instruments are the same as those used aboard all large vessels to obtain information on water depths and potential navigation hazards for vessel crews during routine navigation operations. Navigation echosounders direct a single, high-frequency acoustic signal that is focused in a narrow beam directly downward to the sea floor. The reflected sound energy is detected by the echosounder instrument which then calculates and displays water depth to the user. Typical source levels of these types of navigational echosounders are generally 180–200 dB re 1 µPa at 1 m.

One navigational echosounder would be used by the seismic vessel and another one will be used by the scout vessel. The echosounder used by the seismic vessel will consist of a downward-facing single-beam (Kongsberg EA600) that operates at frequencies of 18 to 200 kHz (output power 1–2 kilowatt [kW]). Associated pulse durations are 0.064 and 4.096 milliseconds (ms) long and repetition frequency of the pulse (i.e., the ping rate) is related to water depth. In shallow water, the highest pulse repetition frequency is about 20 pings per second. The scout vessel will use a Furuno 292 echosounder that operates at a frequency of 28 and 88 kHz. The highest ping rate in shallow water is 12 pings per second.

Dates, Duration and Action Area

As stated earlier, TGS plans to enter the U.S. Chukchi as early as July 15, 2013, and conduct its proposed 2D seismic surveys in both the U.S. Chukchi Sea and international waters through October 31, 2013. Seismic operations are anticipated to occur for about 35 days over a period of 45–60 days in U.S. waters and up to about 33 days in international waters. Operations in U.S. waters are expected to be complete no later than 5 October 2013. However, poor weather, ice conditions, equipment repair, etc., would likely delay or curtail operations. Thus, this extended period allows flexibility in proposed operational dates, contingent on such conditions. Specific proposed dates and durations of project activities are listed below in chronological order, but are contingent on weather and ice, etc.

The seismic operations are proposed to occur in U.S. and international waters of the Chukchi Sea between about 70–77° N and 154–165° W (Figure 1 of TGS' IHA application). Up to approximately 6,088 km of seismic operations with the full sound source are planned to be conducted in U.S. waters as follows, which include 5,973 km of pre-plot lines plus approximately 115 km for 1-km run-in and 5-km run-out between seismic lines. In addition, approximately 1,556 km with the single 60 in^3 (or smaller) mitigation airgun are planned to be conducted during turns and transits between lines. Approximately 3,691 km of seismic operations with the full seismic source as follows are planned to be conducted in international waters, which include 3,631 km of pre-plot lines plus about 60 km of 1-km run-in and 5-km run-out between pre-plot lines. In addition, approximately 812 km with the single 60 in3 (or smaller) mitigation airgun are planned to be conducted during turns and transits between seismic lines. Most of the total approximately 9,600 km of proposed seismic lines occur in water 40–100 m deep (82% or 7,890 km), followed by waters >100 m deep (14% or 1,320 km) and waters <40 m deep (4% or 390 km).

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 eight cetacean species: beluga whale (*Delphinapterus leucas*), harbor porpoise (*Phocoena phocoena*), killer whale (*Orcinus orca*), bowhead whale (*Balaena mysticetus*), gray whale (*Eschrichtius robustus*), minke whale (*Balaenoptera acutorostrata*), fin whale (*B. physalus*), and humpback whale (*Megaptera novaeangliae*), and four pinniped species, ringed (*Phoca hispida*), spotted (*P. largha*), bearded (*Erignathus barbatus*), and ribbon seals (*Histriophoca fasciata*).

The bowhead, fin, 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.

TGS' 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 has 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 Guerreo 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 µPa (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 *el 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 μPa (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 μPa (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 μPa (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 μPa (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; Nieukirk *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 truncates*) 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 μPa (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 μPa^2-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 μPa 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 μPa^2-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 (Urick 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 μPa (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 μPa (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 µPa (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 µPa (rms). That criterion corresponds to a single-pulse SEL of 175–180 dB re 1 μPa^2-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 μPa^2-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 in 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 μPa^2-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 μPa^2-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 μPa^2-s or peak pressure ≥230 dB re 1 µPa. 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 TGS' 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, TGS' 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 TGS' proposed 2D 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 Chukchi 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.

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

TGS' planned seismic surveys would have no or negligible effects on bowhead whale harvest activities. Noise and general activity associated with marine surveys and operation of vessels has the potential to harass bowhead whales. However, though temporary diversions of the swim path of migrating whales have been documented, the whales have generally been observed to resume their initial migratory route. The proposed open-water seismic surveys and vessel noise could affect subsistence hunts by placing the animals further offshore or otherwise at a greater distance from villages thereby increasing the difficulty of the hunt or

retrieval of the harvest, or creating a safety risk to the whalers.

Ten primary coastal Alaskan villages deploy whaling crews during whale migrations. Around the TGS' proposed project area in the Chukchi Sea, the primary bowhead hunting villages that could be affected are Barrow, Wainwright, and Point Hope. 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 and the first week of June in Wainwright, well before the proposed 2D seismic surveys would be conducted. The surveys will start after all the ice melts, usually near mid-July. The Point Hope bowhead whale hunt occurs from March to June. Whaling camps are established on the ice edge south and southeast of Point Hope, 10 to 11 km (6 to 7 mi) offshore. Due to ice conditions, the Point Hope hunt will likely be completed prior to commencement of the surveys. In the fall, whaling activities occur to the east of Point Barrow in the Beaufort Sea, while the proposed survey activities would be in the west of Point Barrow in the Chukchi Sea.

(2) Beluga Whales

Belugas typically do not represent a large proportion of the subsistence harvests by weight in the communities of Wainwright 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. Wainwright residents hunt beluga in April–June in the spring lead system, but this hunt typically occurs only if there are no bowheads in the area. Communal hunts for beluga are conducted along the coastal lagoon system later in July–August. Between 2005 and 2009, the annual beluga subsistence take was 94 whales (Allen and Angliss 2012) among both Wainwright and Barrow.

Belugas typically represent a much greater proportion of the subsistence harvest in Point Lay and Point Hope. Point Lay's primary beluga hunt occurs from mid-June through mid-July, but can sometimes continue into August if early success is not sufficient. Belugas are harvested in coastal waters near these villages, generally within a few miles from shore. However, the southern extent of TGS' proposed surveys is over 88 m to the north of Point Lay, and much farther away from Point Hope. Therefore NMFS considers that the surveys would have no or negligible effect on beluga hunts.

(3) Seals

Seals are an important subsistence resource and ringed seals make up the bulk of the seal harvest. Most ringed and bearded seals are harvested in the winter or in the spring before TGS' 2013 activities would commence, but some harvest continues during open water and could possibly be affected by TGS' planned activities. Spotted seals are also harvested during the summer. Most seals are harvested in coastal waters, with available maps of recent and past subsistence use areas indicating seal harvests have occurred only within 30–40 mi (48–64 km) off the coastline. TGS does not plan to survey within 88 km (55 mi) of the coast, which means that the proposed activities are not likely to have an impact on subsistence hunting for seals.

As stated earlier, the proposed seismic survey would take place between July and October. The proposed seismic survey activities would be conducted in far offshore waters of the Chukchi Sea and away from any subsistent activities. In addition, the timing of the survey activities that would be conducted between July and October would further avoid any spring hunting activities in Chukchi Sea villages. Therefore, due to the time and spatial separation of TGS' proposed 2D 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, TGS 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). TGS 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 TGS' proposed open-water seismic surveys to subsistence activities, TGS 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 TGS open-water marine 2D seismic surveys in the Chukchi Sea, TGS 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 is 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 μPa for cetaceans and ≥190 dB (rms) re 1 μPa 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 (Richarcdson *et al.* 1995). Currently, NMFS uses 160 dB (rms) re 1 μPa as the threshold for Level B behavioral harassment from impulses noise.

The acoustic source level of the proposed 3,280 in^3 seismic source array was predicted using JASCO's airgun array source model (AASM) based on data collected from three sites chosen in the project area by JASCO. Water depths at the three sites were 17, 40, and 100 m. JASCO applied its Marine Operations Noise Model (MONM) to estimate acoustic propagation of the proposed seismic source array and the associated distances to the 190, 180 and 160 dB (rms) re 1 µPa isopleths relative to standard NMFS mitigation and monitoring requirements for marine mammals. The resulting isopleths modeled for the 180 and 190 dB (rms) re 1 µPa exclusion zone distances for cetaceans and pinnipeds, respectively, differed with the three water depths. An additional 10 percent distance buffer was added by JASCO to these originally modeled distances to provide larger, more protective exclusion zone radii. The modeled exclusion zones and zones of influence are listed in Table 1.

These safety distances will be implemented at the commencement of 2013 airgun operations to establish marine mammal exclusion zones used for mitigation. TGS 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 Chukchi Sea seismic survey activities, including the supporting vessel.

- Avoid concentrations or groups of whales by all vessels under the direction of TGS. 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, TGS will employ the use of a small-volume airgun (i.e., 60 in^3 ''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 daylight hours. In cases when the next start-up after the turn is expected to be during lowlight or low visibility, continuous operation of mitigation airgun is permitted.

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

TGS 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.

TGS has prepared a POC, which relies upon the Chukchi Sea Communication Plans to identify the measures that TGS has developed in consultation with North Slope subsistence communities and will implement during its planned 2013 activities to minimize any adverse effects on the availability of marine mammals for subsistence uses. The POC describes important subsistence activities near the proposed survey program and summarizes actions TGS has taken to inform subsistence communities of the proposed survey activities; and measures it will take to minimize adverse effects on marine mammals where proposed activities may affect the availability of a species or stock of marine mammals for arctic subsistence uses or near a traditional subsistence hunting area.

TGS began stakeholder engagement by introducing the project to the North Slope Borough (NSB) Planning Commission on October 25, 2012, and it also met with the NSB Planning Director and other Barrow leadership. In December 2012, TGS met with Chukchi Sea community leaders at the tribal, city, and corporate level in Barrow, Wainwright, Point Hope, Point Lay, and Kotzebue. TGS also introduced the project to the Alaska Eskimo Whaling Commission (AEWC) at their 4th Quarter Meeting on December 13–14, 2012, in Anchorage.

Community POC meetings were held in Barrow, Kotzebue, Point Hope, Point Lay, and Wainwright in January and February 2013. Finally, in February 2013, TGS participated the AEWC mini-convention and on Conflict Avoidance Agreement (CAA) discussion. A final POC that documents all consultations with community leaders and subsistence users was submitted to NMFS in May, 2013.

In addition, TGS signed a CAA with the Alaska whaling communities to further ensure that its proposed open-water seismic survey activities in the Chukchi 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 TGS 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 Chukchi Sea during 2013 by conducting vessel-based monitoring from both source vessel and supporting vessel and an acoustic monitoring program to using towed hydrophone array to document marine mammal presence and distribution in the vicinity of the survey area beyond visual observation distances.

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 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 Chukchi Sea.

Real-time PAM would be conducted from the supporting vessel to complement the visual monitoring conducted by PSOs during the seismic surveys in the Chukchi Sea. Studies have indicated that towed PAM is a practical and successful application for augmenting visual surveys of low-frequency mysicetes, including blue and fin whales (Clark and Fristrup 1997). Passive acoustics methods, including towed hydrophone arrays, are most effective in remote areas, harsh environments (e.g. the arctic) and when visibility and/or sea conditions are poor,

or at nighttime or during low-light conditions when animals cannot be sighted easily. Surveys have collected more acoustic detections than visual observations while using towed PAM in the Arctic during an open-water seismic survey program conducted by Statoil in 2010 (McPherson *et al.* 2012). TGS states that the designed PAM system would provide the possibility of advanced real-time notification of vocalizing marine mammals that are not observed visually (or are observed after acoustic detection) and allow for mitigation actions (i.e., power-down, shut-down) to take place, if necessary.

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 and supporting vessels 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.

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 Zeiss Binoculars or Fujinon 25 x 150 ''Big-eye'' 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 support 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 μPa (rms) for cetaceans, or 190 dB (rms) re 1 μPa for pinnipeds.

Distances to nearby marine mammals will be estimated with binoculars (Fujinon 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 Chukchi 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).

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 Mysticetus™ 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, and will be built into the Mysticetus™ software (i.e., Mysticetus™ will recognize and notify the operator if entered data are non-sensical). 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. Mysticetus™ will be used to quickly and accurately summarize and display these data.

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) Real-Time Passive Acoustic Monitoring

TGS will conduct real-time passive acoustic monitoring using a towed hydrophone array from the support vessel. The towed hydrophone array system consists of two parts: The ''wet end'' and the ''dry end''. The wet end consists of the hydrophone array and tow cable that is towed behind the vessel. The dry end includes the analog-to-digital, computer processing, signal conditioning and filtering system used to process, record and analyze the acoustic data. Specific noise filters will be used to maximize the systems ability to detect low frequency bowhead whales. The towed hydrophone array will be deployed using a winch from the scout vessel. Details and specifications on the equipment will be determined at a later date once TGS has selected an acoustics contractor, as each contractor has different equipment specifications.

Localization of vocalizing animals will be accomplished using target motion analysis. With this method, it is possible with a single towed hydrophone array to obtain a localization to vocalizing animals given certain assumptions. Due to the linear alignment of hydrophones, there is a left/right ambiguity that cannot be resolved without turning the tow vessel. The left/right ambiguity, however, is not a critical concern for mitigation during the TGS 2D seismic survey because the exclusion zones are circular; therefore, the distance to the calling animal is the same on the right and left side of the vessel. Furthermore, unambiguous localization can be achieved in circumstances where the vessel towing the array can turn and the calling animals call multiple times or continuously.

To ensure the effectiveness of real-time PAM with a towed hydrophone array, the following requirements for PAM design and procedures will be required:

Lowering Interferences From Flow Noise

- Limit towing speeds to 4–6 knots. Reduce speed appropriately if bowhead whales are detected so that bearing can be obtained. If greater speeds are necessary, slow down every 20–30 minutes to listen for animal calls for at least 5–10 minutes.
- Maintain straight track-lines unless right/left ambiguity must be resolved (usually by turning 20–30 degrees at a time, then maintaining a straight course until good bearings can be obtained).
- Maintain a separation distance of at least several hundred meters (preferably more) from the seismic survey vessel.
- Design pre-amplifier filters that are 'tuned' to reduce low-frequency flow and vessel noise.
- If necessary, use a variable high-pass filter before digitizing the signals.

Monitoring Marine Mammal Occurrence Within 160 dB Isopleths

- Design a hydrophone array that is sensitive to frequencies of interest (e.g. marine mammal sounds) but attenuates (via filters) noise.
- Use a processing system that can further signal conditions (i.e. filter and match signal gains) to allow software to effectively estimate bearings and/or localize.
- Use software designed exclusively for monitoring, localizing and plotting marine mammal calls.
- Design the sampling software to optimize overlap between monitoring the 180 and 160 dB isopleths.
- Allow the survey vessel to deviate from designated track-lines by 25–30 degrees (for brief periods) so that left/right ambiguity can be resolved.

Increase Localization Capability

- Start with a simple hydrophone array, and if needed, add additional capabilities (or hydrophones) to supplement this system. For example, a 2-hydrophone array that can do TMA but with an additional array (or inline section) that can be added in front of the primary array would allow crossed-pair localization methods to be used.
- Use a processing and geographic display system that can accommodate at least the TMA localization method, but also, additional methods if needed.
- Provide at least 300 m of cable (for TMA methods), and up to 500 m if crossed-pair or hyperbolic localization methods will be used.

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 TGS' 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 Chukchi Sea during 2013. The panel met on January 8 and 9, 2013, and provided their final report to NMFS in March 2013. The full panel report can be viewed at: *http://www.nmfs.noaa.gov/pr/permits/incidental.htm#applications*.

NMFS provided the panel with TGS' monitoring and mitigation plan and asked the panel to address the following questions and issues for TGS' 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 report contains recommendations that the panel members felt were applicable to the TGS' 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 the TGS' proposed marine mammal monitoring and mitigation plan, TGS only proposed vessel-based visual monitoring (but subsequently added PAM as described above). The panel was particularly concerned that there are considerable limitations to the ability of PSOs to monitor the full extent of the zones of influence, as these zones extend to as far as 15 km beyond the source. In addition, the panel pointed out that TGS did not specify how it planned to operate the scout vessel for marine mammal monitoring.

Specific recommendations provided by the peer review panel to enhance marine mammal monitoring, especially far distance monitoring beyond exclusion zones, include: (1) Implementing passive acoustic monitoring, with the bottom mounted passive acoustic recorders probably being the most appropriate method; (2) deploying a real-time, passive acoustic monitoring device that is linked by satellite (i.e., Iridium) phone; (3) collaborating with NMFS to use aerial survey data for assessing marine mammal distribution, relative abundance, behavior, and possible impacts relative to seismic surveys; (4) looking into possibility of using unmanned aerial systems to survey for marine mammals in offshore areas; and (5) utilizing new technologies, such as underwater vehicles, gliders, satellite monitoring, etc., to conduct far-field monitoring.

NMFS discussed extensively with TGS to improve the far-field marine mammal monitoring. As a result, upon further investigation and conversations with both JASCO and Bio-Waves by TGS, as well as further research into past Arctic marine mammal monitoring results conducted with towed-PAM, NMFS and TGS agree that utilizing a well-designed towed-PAM system would meet the need to provide enhanced marine mammal monitoring beyond exclusion zones, as well as using acoustic data for limited relative abundance and distribution analysis, and possibly limited insights on impacts to marine mammals.

NMFS also studied other PAM methodologies suggested by the peer-review panel. First, concerning deploying fixed bottom mounted recorders, TGS states that it has been in contact with other operators but was not able to find a collaborator to participate in long-term acoustic monitoring due to the short-term nature of the proposed survey. Regarding the real-time acoustic monitoring with fixed buoy, TGS stated that it conducted an evaluation of this option and discussed the possibility with the Cornell University's Bioacoustical Research Program concerning its real-time marine acoustic recording unit (MARU), but decided that the technology is still in the research and development stage. TGS also states that it did not consider the technology because the cost is more expensive than other PAM methods. TGS also discussed (with NMFS scientists) the possibility of using NMFS' aerial survey data for assessing marine mammal distribution, relative abundance, and possible impacts relative to seismic surveys. However, most of TGS' survey areas are outside NMFS aerial survey area, which makes it im possible to use these datasets for impact analyses. TGS also did a cost-benefit analysis of manned aerial surveys, and eliminated this as an option due to increased health and safety exposure risk, especially north of 72° N. TGS also investigated the possibility of using unmanned aerial vehicle (UAV) to survey for marine mammals in offshore areas, however, it has also turned out not to be feasible due to the fact that the approach is currently awaiting an FAA permit to operate in the Arctic, and this permit could not be guaranteed to be obtained in time for the TGS monitoring effort. TGS states that it did consider new technologies, but did not feel that they could justify the expense of testing techniques with unknown capabilities in the Arctic environment.

In addition, the panel also recommends that TGS collaborate with other organizations operating in the Chukchi Sea and share visual and acoustic data to improve understanding of impacts from single and multiple operations and efficacy of mitigation measures. Accordingly, TGS plans to share these data via the OBIS–SEAMAP Web site entertaining all appropriate data-sharing agreements, including data obtained using towed PAM.

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.

Field Reports

Throughout the survey program, PSOs will prepare a report each day or at such other intervals, summarizing the recent results of the monitoring program. The reports will summarize the species and numbers of marine mammals sighted. These reports will be provided to NMFS and to the survey operators.

Technical Reports

The results of TGS' 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 for the proposed open-water 2D seismic surveys. 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 TGS 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. TGS 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 TGS that is not in the vicinity of the proposed open-water marine survey program, TGS 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 2D seismic surveys, NMFS uses the 160 dB (rms) re 1 μPa isopleth to indicate the onset of Level B harassment. TGS 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. TGS 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 estimated takes by harassment is calculated in this section by multiplying the expected densities of marine mammals that may occur near the planned activities by the area of water likely to be exposed to impulse sound levels of ≥160 dB (rms) re 1 μPa.

Marine mammal occurrence near the operation is likely to vary by season and habitat, mostly related to the presence or absence of sea ice. Although current NMFS' noise exposure standards state that Level B harassment occurs at exposure levels ≥160 dB (rms) re 1 μPa by impulse sources, there is no evidence that avoidance at these received sound levels would have significant biological effects on individual animals. Any changes in behavior caused by sounds at or near the specified received levels would likely fall within the normal variation in such activities that would occur in the absence of the planned operations. However, these received levels are currently used to set the threshold for Level B behavioral harassment.

Marine Mammal Density Estimates

The first step in estimating the number of marine mammals that might be ''taken by harassment'' was to conduct a review of available data on density estimates for the marine mammal species occurring in the project vicinity and adjacent areas of the Chukchi Sea. While several densities are available for U.S. waters in the Chukchi Sea, no reliable estimates are known for U.S. waters north of 72° N. Furthermore, no systematic surveys are known for the western half of the proposed project area in international waters.

Therefore, densities used to estimate exposures were based on two recent IHA applications and three 90-day reports to NMFS summarizing results of field monitoring surveys. These project areas overlapped the proposed TGS project area to at least some extent as well as TGS' proposed July–October seismic operations period. A map showing the boundaries of these survey areas relative to TGS' proposed seismic line locations is provided in Figure 2 of TGS' IHA application. The surveys consisted of the (1) two Statoil 90-day reports from the northern Chukchi Sea (Blees *et al.* 2010; Hartin *et al.* 2011), (2) UAGI's IHA (LGL 2011) and 90-day report (Cameron *et al.* 2012), and (3) Shell 2012 IHA (Shell 2011). These data are considered the ''best available'' density estimates and occurrence data currently available for the project area.

All recent density estimates for four different project areas overlapping the TGS project area based on the observed or derived densities reported in other studies (Blees *et al.* 2010; Hartin *et al.* 2011; LGL 2011; Shell 2011; Cameron *et al.* 2012) and are shown in Table 3 of TGS' IHA application. Note that only the Cameron *et al.* (2012) survey occurred north of 72° N in U.S. waters and international waters partially overlapping the TGS project area. Sightings providing data on observed densities were available for the following six species: the bowhead, gray and beluga whale, and the bearded, ringed and spotted seal. The remaining other six species occur so rarely in the project area vicinity that reliable densities are not available for them and/or no sightings were made during the

reported surveys: the humpback, minke, fin, and killer whales, the harbor porpoise, and the ribbon seal (Blees *et al.* 2010; Hartin *et al.* 2011; Cameron *et al.* 2012). Thus, certain fractional numbers were assigned to them based on those reported for other IHAs overlapping the proposed TGS project area, to address the rare chance of an encounter (Blees *et al.* 2010; Hartin *et al.* 2011; LGL 2011; Shell 2011; Cameron *et al.* 2012).

Adjustment Factors Applied To Provide Lower and Upper Estimates of Density

A number of habitat parameters have been shown to influence the distribution of marine mammal species occurring in the TGS project area. These parameters were applied to adjust the density of species accordingly, as done by other applicants in previous IHA applications (e.g., Blees *et al.* 2010; Hartin *et al.* 2011; LGL 2011; Shell 2011, Cameron *et al.* 2012). These included (1) open water (i.e., ice-free) vs. ice-edge margin (higher densities of pinnipeds and beluga whales occur near and/or within the ice margin), (2) summer (July–August) vs. fall (September–October), (3) water depth (>200 vs. <200 m deep), and (4) likelihood of occurrence above or below 72° N. Open-water densities were used if available because TGS operations must completely avoid ice to be able to safely and effectively conduct operations.

Densities (Table 3 in TGS' IHA application) used to estimate and calculate the number of exposures to TGS' seismic impulse sound levels ≥160 dB (rms) re 1μ Pa were obtained by (1) averaging the densities from the four previous studies by summer (July–August), fall (September–October), and summer-fall, and then (2) multiplying the resulting averaged densities by adjustment factors for water depth (shallower or deeper than 200 m) and expected occurrence in waters north or south of 72° N. Notably, TGS plans to operate above 72° N for about half (32 days) of the total 45- 60-day period in US Federal waters (35 days of which would involve seismic operations), and for all operations in international waters, up to 33 days. These northern waters above 72° N would be accessed sometime between about mid-September and 15 October (when waters are ice-free).

Because few data were available for most of the survey area, particularly north of 72° N and west of Barrow, it is not known how closely the applied average densities reflect the actual densities that will be encountered during the proposed TGS seismic survey. Thus, lower and upper adjustment factors (Table 4 in TGS' IHA application) were multiplied by the averaged densities to provide a range of density estimates. The latter adjustment was incorporated into a formula to estimate exposures to seismic sounds. The ''lower adjustment factor'' does not apply adjustment factors to densities north of 72° N for the bowhead and beluga whale and the ringed and bearded seal. In contrast, the ''upper adjustment factor'' applies factors to account for the expected lower density of marine mammal species north of 72° N. Adjustment factors differed by species and were based on (1) the reported distribution and occurrence of each species in these waters, and (2) factors applied by ION (LGL 2012) for their 2012 IHA application for the fall period of Oct–Dec 2012 that overlapped the fall period (mid-to-late September–October) and north-easternmost region that TGS expects to operate in international waters during fall.

TGS applied these density data and factors previously applied in an IHA issued to ION to account for expected lower densities above 72° N where waters are predominantly >1,000 m deep. The upper-adjusted (i.e., lower) density estimate was calculated by multiplying reported fall densities for more southern Chukchi waters as follows: (1) by a factor of 0.0 for fin, humpback, minke and killer whales, and harbor porpoise and ribbon and spotted seals as they are not expected in waters above 72° N and thus were assumed not to occur there; (2) by an adjustment factor of 0.01 for gray whales (since the northernmost boundary of their distribution is near 72° N and they are thus considered highly unlikely to occur above 72° N; (3) by a factor of 0.1 for bowhead whales as the area is outside the main migration corridor, and (4) by a factor of 0.1 for beluga whales and bearded and ringed seals as they are closely associated with ice, and thus considered less likely to occur in ice-free waters needed to conduct the TGS seismic operations.

A similar 0.1 adjustment factor was applied in the ION IHA (LGL 2012) for species where the seismic survey area was on the edge of that species' range at the given time of year. ION's adjustment factor of 0.1 was used for TGS density estimates because TGS proposes to be well north and west of ION's westernmost 2012 survey lines no earlier than 15–30 September through 31 October 2013. In comparison, ION proposed their program for 1 October through mid-December, and their actual program occurred in the Chukchi and Beaufort Seas from 20 October–9 November, 2012. These periods overlap the majority of the period that TGS is expected to be operating at or near the westernmost seismic lines (no earlier than 15–30 September through October) between 73°–76° N and 160° W to 160° E. Thus, ION's ''late season'' period coincides with TGS' proposed late fall season both in time and space relative to waters above 72° N.

The upper density estimates consisted of the averaged fall densities for more southern Chukchi waters by only (1) a smaller adjustment factor of 0.20 for gray whales (Table 4 of TGS' IHA application), and (2) by the same factor of 0.0 for fin, humpback, minke and killer whales, and harbor porpoise and ribbon and spotted seals as described above.

Additional Rationale for Adjusting Densities North of 72° N

- No whale sightings have been reported in waters north of 72° N during the few recent vessel-based surveys conducted there that overlapped the southern or eastern part of the proposed TGS project area and season (Blees *et al.* 2010; Hartin *et al.* 2011; Cameron *et al.* 2012).
- The main fall migration corridor for bowheads reportedly occurs south of 72° N (Quakenbush *et al.* 2010). However, satellite-tagging studies indicate that at least some individual bowheads migrate generally west/southwest across the project area in waters above 72° N and west of Barrow during the fall migration from September–November (Quakenbush 2007; LGL 2011; Quakenbush *et al.* 2012).
- The reported gray whale distribution in the Chukchi Sea normally does not extend much north of 72° N during summer/fall (Jefferson *et al.* 2008). This northernmost peripheral boundary area is thus expected to have very low gray whale densities. Furthermore, most gray whales will have migrated south of the project area by fall (Rice and Wolman 1971; Allen and Angliss 2012).

Exposure Calculation Methods

The approach used to calculate the estimated number of individuals of each marine mammal species potentially exposed to received levels of seismic impulse sound levels ≥160 dB (rms) re 1 μPa during the proposed seismic project is described below.

1. The area of water (in km^2) ensonified to ≥160 dB (rms) re 1 μPa around the operating seismic source array on seismic lines as well as turns and transits between seismic lines was calculated for U.S. and international waters for waters shallower and deeper

than 200 m, and for waters north and south of 72° N (Table 2). It was assumed for purposes of this estimation that the full seismic source array would be used during all seismic lines and during the 1-km run-in and 5-km run-out between seismic lines. In addition, it was assumed that a single 60 in^3 airgun would be used during turns and transits between seismic lines. Ensonified waters were calculated as follows.

2. A buffer was applied on both sides of the planned survey tracklines equivalent to the distances modeled for the proposed 3,280 in^3 seismic source array by JASCO in 2010 at three locations in the project area (Zykov *et al.* 2013). The buffer width corresponding to this 160 (rms) dB re 1 µPa isopleth varied with three water depth categories. Thus, survey tracklines located over waters 17–40 m deep were buffered by 8.5 km, those over waters 41–100 m deep were buffered by 9.9 km, and those over water depths of >100 m were buffered by 15 km.

TABLE 2—ESTIMATED AREA (KM^2) ENSONIFIED TO >160 DB (RMS) RE 1 µPA BY SEISMIC IMPULSES ALONG TGS' 2013 PROPOSED SEISMIC LINES AND TURNS IN U.S. AND INTERNATIONAL WATERS OF THE CHUKCHI SEA. ENSONIFIED AREAS ASSUMED THAT THE FULL 3,280 IN^3 ARRAY OPERATED CONTINUOUSLY ON SURVEY LINES AND THAT THE SINGLE MITIGATION AIRGUN (60 IN^3) OPERATED CONTINUOUSLY ON TURNS (AND TRANSITS) BETWEEN SURVEY LINES

	Above 72° N		Below 72° N		Water depth < 200 m		Water depth > 200 m		All lines	All turns	All lines and turns
	Total lines area (km^2)	Turns area (km^2)	Total lines area (km^2)	Turns area (km^2)	Total lines area (km^2)	Turns area (km^2)	Total lines area (km^2)	Turns area (km^2)	Total lines area (km^2)	Total turns area (km^2)	Total ensonified area (km^2)
US	65477	1294	72974	1442	114858	2770	23594	466	138452	2736	141188
International	115135	4200	0	0	45954	1676	69181	2524	115135	4200	119335
Total	180612	5494	72974	1442	160812	3946	92775	2990	253586	6936	260522

3. A smaller buffer was applied to both sides of turn lines between seismic lines equivalent to the measured distance to the 160 dB (rms) re 1 µPa isopleth of a single 60 in^3 array as measured by JASCO. The associated area in km^2 was calculated using Mysticetus™ software. Mysticetus™ identified water depths at 100-m intervals along the survey trackline using bathymetric data. At each 100-m interval, Mysticetus™ applied one of the three aforementioned 160 dB (rms) re 1 µPa radius isopleths corresponding to that water depth. Overlapping areas were treated separately. The resulting World Geodetic System (WGS) 84 polygons were re-projected into North Pole Stereographic coordinates and the total area was calculated.

4. Averaged densities of marine mammals (Table 3 in TGS' IHA application) were adjusted as applicable (Table 4 in TGS' IHA application) then multiplied by the area predicted to be ensonified to ≥160 dB (rms) re 1 µPa. The procedure is outlined below.

- Because TGS expects to conduct seismic lines in U.S. Federal waters sometime between mid-July and mid-September in late summer and early fall, the proportion of U.S. Federal waters ensonified to >160 dB (rms) re 1 µPa was multiplied by the average of summer and fall densities reported from other studies (Table 3 in TGS' IHA application).
- Because TGS expects to conduct seismic lines in international waters starting in fall from mid-to-late September through October, the proportion of international waters ensonified to >160 dB (rms) re 1 µPa was multiplied by the average of fall densities reported from other studies (based nearly exclusively on surveys south of 72° N since it is considered the best and only systematic data available for the region).
- The proportions of ensonified waters north and south of 72° N were also calculated for U.S. and international waters. Species-specific average summer-fall and fall densities associated with these depth categories were multiplied by the corresponding proportion and season.
- In addition, the proportions of ensonified waters where water depth along the seismic line was <200 m deep or >200 m deep were calculated. Species-specific average summer-fall and fall densities associated with these depth categories were multiplied by the corresponding proportion and season.
- Reported fall density estimates for gray, bowhead and beluga whales, and bearded and ringed seals were adjusted for ice-free waters N of 72° N by multiplying reported fall densities for more southern Chukchi waters by low and high adjustment factors described above to provide a range of potential exposures.

In a summary, estimated species exposures are calculated by multiplying seasonally (summer vs. fall) and spatially (above vs. below 72° N at various water depths) marine mammal density by the total ensonified areas with received levels higher than 160 dB re 1µPa (rms).

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 Chukchi Sea and the anticipated area exposed to those sound pressure levels (SPLs) above 160 dB re 1 µPa for impulse sources (seismic airgun during 2D seismic surveys).

Some of the animals estimated to be exposed, particularly migrating bowhead whales, might show avoidance reactions before being exposed to sounds at the specified threshold levels. Thus, these calculations actually estimate the number of individuals potentially exposed to the specified sounds levels that would occur if there were no avoidance of the area ensonified to that level.

Numbers of marine mammals that might be present and potentially taken are summarized in Table 3 based on calculation described above.

TABLE 3—ESTIMATES OF THE POSSIBLE MAXIMUM NUMBERS OF MARINE MAMMALS TAKEN BY LEVEL B HARASSMENT (EXPOSED TO ≥160 dB FROM AIRGUN SOUND) DURING TGS' PROPOSED 2D SEISMIC SURVEY IN THE CHUKCHI SEA, JULY–OCTOBER 2013

Species	Level B takes	Percent population
Bowhead whale	794	7.53
Gray whale	1,363	7.13
Fin whale	5	0.09
Humpback whale	5	0.53
Minke whale	5	0.62
Beluga whale	412	11.11
Killer whale	5	1.59
Harbor porpoise	36	0.07
Ringed seal	30,000	14.36
Bearded seal	6000	0.84
Spotted seal	500	0.84
Ribbon seal	100	0.20

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 794 bowhead whales may be exposed to sounds at or above 160 dB (rms) re 1 μPa (Table 3). This number is approximately 7.53% 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 gray and beluga whales that may be exposed to sounds from the activities ranges up to 1,363 and 412, respectively (Table 3). Fewer harbor porpoises are likely to be exposed to sounds during the activities. The small numbers of other whale species that may occur in the Chukchi 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 30,000, which represent up to 14.36% 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.

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 TGS' proposed 2013 open-water 2D seismic surveys in the Chukchi 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 μPa. 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 Chukchi 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 10 seconds 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 TGS' 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 thirteen marine mammal species likely to occur in the proposed marine survey area, bowhead, fin, 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, fin, 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 11.11% of the Eastern Chukchi Sea population of approximately 3,710 beluga whales, 1.59% of Aleutian Island and Bering Sea stock of approximately 314 killer whales, 0.07% of Bering Sea stock of approximately 48,215 harbor porpoises, 7.13% of the Eastern North Pacific stock of approximately 19,126 gray whales, 7.53% of the Bering-Chukchi-Beaufort population of 10,545 bowhead whales, 0.53% of the Western North Pacific stock of approximately 938 humpback whales, 0.09% of the Northeast Pacific stock of approximately 5,700 fin whales, and 0.62% of the Alaska stock of approximately 810 minke whales. The take estimates presented for ringed, bearded, spotted, and ribbon seals represent 14.36, 2.47, 0.84, and 0.20% 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 the TGS' 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 Chukchi 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 TGS' proposed 2013 open-water 2D seismic surveys in the Chukchi 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 TGS' proposed 2013 open-water 2D seismic surveys in the Chukchi 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 TGS' POC. TGS has adopted a spatial and temporal strategy for its Chukchi 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 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, based on the measures described in TGS' 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 TGS' 2013 open-water 2D seismic surveys in the Chukchi 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 2D seismic surveys and related activities in the Chukchi Sea. The specific areas where TGS' surveys will be conducted are within the Chukchi Sea, Alaska, as shown in Figure 1 of TGS' IHA application.

(3)(a) The species authorized for incidental harassment takings, Level B harassment only, are: Beluga whales (*Delphinapterus leucas*); harbor porpoises (*Phocoena phocoena*); killer whales (*Orcinus orca*); bowhead whales (*Balaena mysticetus*); gray whales (*Eschrichtius robustus*); humpback whales (*Megaptera novaeangliae*); fin whales (*Balaenoptera physalus*); minke whales (*B. acutorostrata*); 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) 3,280 in^3 airgun arrays and other acoustic sources for 2D 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 1 (attached). 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 μPa. For purposes of the field verification test, described in condition 7(e)(i), these radii are estimated to be 2,200, 2,500, and 2,400 m from the seismic source for

the 3,280 in^3 airgun array in water depths of 17–40, 40–100, and >100 m, respectively. The 180-dB radius from the single 60 in^3 airgun is estimated to be at 68 m from the source, regardless of water depth.

(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 μPa. For purposes of the field verification test, described in condition 7(e)(i), these radii are estimated to be 930, 920, and 430 m from the seismic source for the 3,280 in^3 airgun array in water depths of 17–40, 40–100, and >100 m, respectively. The 190-dB radius from the single 60 in^3 airgun is estimated to be at 13 m from the source, regardless of water depth.

(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 μPa. For purposes of the field verification test described in condition 7(e)(i), these radii are estimated to be 8,500, 9,900, and 15,000 m from the seismic source for the 3,280 in^3 airgun array in water depths of 17–40, 40–100, and >100 m, respectively. The 160-dB radius from the single 60 in^3 airgun is estimated to be at 1,500 m from the source.

(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 (2 or more individuals) by all vessels under the direction of TGS. 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 complete shutdown of 10 minutes or more, 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 small odontocetes (harbor porpoise) and pinnipeds, or 30 minutes for baleen whales and large odontocetes (including beluga and killer whales and narwhal).

(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 small toothed whales) or 30 minutes (baleen whales or large toothed whales).

(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, TGS will employ the use of a small-volume airgun (i.e., 60 in^3 ''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 daylight hours. In cases when the next start-up after the turn is expected to be during lowlight or low visibility, continuous operation of mitigation airgun is permitted.

(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 TGS' 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 vessel and supporting 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.

(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) TGS 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 Zeiss Binoculars or Fujinon 25 x 150 ''Big-eye'' 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 (Fujinon 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) TGS 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) 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 μPa 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) Real-time Passive Acoustic Monitoring (PAM).

(A) TGS shall conduct real-time passive acoustic monitoring by NMFS-approved passive acoustic monitor(s) using a towed hydrophone array from the support vessel throughout the open-water seismic surveys.

(B) Passive Acoustic Operator(s) and Monitor(s):

(I) Design and initial setup of PAM apparatus (including hardware and software) shall be done by experienced bioacoustician(s) with field experience in marine mammal passive acoustic monitoring and signal processing.

(II) Passive acoustic monitor(s) shall undergo basic training on PAM, and be able to operate independently once the PAM apparatus is set-up.

(III) Resumes for the bioacoustician(s) and passive acoustic monitor(s) candidates shall be provided to NMFS for review and acceptance of their qualifications.

(C) Specific sensor design and noise filters shall be used to maximize the system's ability to detect low frequency bowhead whales. To ensure the effectiveness of real-time PAM with a towed hydrophone array, the following requirements for PAM design and procedures are required:

(I) Limit towing speeds to 4–6 knots. Reduce speed appropriately, or change direction if necessary, so that if bowhead whales are detected so that bearing can be obtained. If greater speeds are necessary, slow down every 20–30 minutes to listen for animal calls for at least 5–10 minutes.

(II) Maintain a separation distance of at least several hundred meters (preferable more) from the seismic survey vessel.

(D) Best efforts shall be made without compromising data collection to localize vocalizing marine mammals.

(I) Use a signal conditioning system (i.e. filter and match signal gains) to allow software to effectively estimate bearings and/or localize.

(II) Use software designed exclusively for monitoring, localizing and plotting marine mammal calls.

(III) Design the sampling software to optimize overlap between monitoring the 180 and 160 dB isopleths.

(IV) Allow the support vessel to deviate from designated track-lines by 25–30 degrees (for brief periods) so that left/right ambiguity can be resolved if needed.

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

(i) Data for periods when a seismic array is active and when it is not; and

(ii) The respective predicted received sound conditions over fairly large areas (tens of km) around operations.

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

(d) To better understand the potential effects of oil and gas activities on marine mammals and to facilitate integration among companies and other researchers, the following data should be obtained and provided electronically in the 90-day report:

(i) the location and time of each vessel-based sighting or acoustic detection;

(ii) position of the sighting or acoustic detection relative to ongoing operations (i.e., distance from sightings to seismic operation, etc.), if known;

(iii) the nature of activities at the time (e.g., seismic on/off);

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

(v) adjustments made to operating procedures.

(e) TGS shall provide useful summaries and interpretations of results of the various elements of the monitoring results, which shall include a clear timeline and spatial (map) representation/summary of operations and important observations. Any and all mitigation measures (e.g., vessel course deviations for animal avoidance, operational shut down) should be summarized. Additionally, an assessment of the efficacy of monitoring methods should be provided.

(f) TGS shall collaborate with other organizations operating in the Chukchi 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 TGS' 2013 open-water seismic surveys in the Chukchi 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), TGS 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 TGS to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. TGS may not resume their activities until notified by NMFS via letter, email, or telephone.

(b) In the event that TGS 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), TGS 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 TGS to determine whether modifications in the activities are appropriate.

(c) In the event that TGS 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), TGS 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. TGS shall provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS and the Marine Mammal Stranding Network. TGS 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) TGS 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, fin, 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 TGS' 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 TGS 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 TGS' 2013 open-water 2D seismic surveys in the Alaskan Chukchi Sea, provided the previously mentioned mitigation, monitoring, and reporting requirements are incorporated.

Dated: June 6, 2013.

Donna S. Wieting,

Director, Office of Protected Resources, National Marine Fisheries Service.

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