



US Oil & Gas
Association



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Reference: RIN 0648-XA397. Taking and Importing Marine Mammals; Geological and Geophysical Exploration of Mineral and Energy Resources on the Outer Continental Shelf in the Gulf of Mexico.

The American Petroleum Institute (API), the International Association of Geophysical Contractors (IAGC), the Independent Petroleum Association of America (IPAA), the National Ocean Industries Association (NOIA) and the US Oil & Gas Association (USOGA) (hereinafter referred to as "the Associations") are pleased to provide the following comments in response to the June 14, 2011 National Marine Fisheries Service Federal Register Notice of Receipt of revised Application from the Bureau of Ocean Energy Management, Regulation, and Enforcement (BOEMRE) for Letters of Authorization (LOA) to "take" marine mammals incidental to seismic surveys for purposes of geological and geophysical exploration (G&G) on the Outer Continental Shelf (OCS) in the Gulf of Mexico (GOM).

The Associations represent hundreds of companies engaged in the exploration for and development of offshore oil and gas resources. The exploration activity covers a wide range of activities, which includes seismic as well as low impact, passive acquisition technologies like gravity, magnetic and micro seismic techniques. All seismic exploration techniques help reduce the safety and environmental exposure of future exploration activities. Some member companies offer seismic survey services, support them or acquire those services as a necessary and critical activity in the search for future supplies to fuel the nation's economy. As

is well documented, future oil discoveries are extremely difficult - if not nearly impossible without modern seismic-acoustic imaging techniques.

This action and future associated rulemaking has significant ramifications on domestic offshore oil and gas production and therefore should be handled with the care afforded major rulemaking with economic impacts greater than \$100 million.

At present, there are no commercially available and viable alternatives to current geophysical imaging technologies, which have been employed but continuously refined over the last six decades to be more efficient and emit less sound energy. Improvements in seismic technologies have offered improved precision in subsurface imaging resulting in environmental benefits including the need for fewer facilities and improved drilling success and safety.

Future Implications

The Bureau of Ocean Energy Management Regulation and Enforcement (BOEMRE) request to revise the petition for an incidental taking of marine mammals in the Gulf of Mexico is an initiating event that will trigger future agency action necessary for development of a 5-year rule necessary for the National Marine Fisheries Service to issue Letters of Authorization under the Marine Mammal Protection Act (MMPA) to industry applicants.

We applaud BOEMRE and NMFS for moving forward with the process of developing Incidental take regulations for seismic surveys on the GOM OCS.

History of the Rulemaking

The NMFS June 14, 2011 Federal Register Notice notes some but not all of the history necessary to understand that this effort has been long underway:

- July 2002 – NMFS issues Biological Opinion for Gulf of Mexico Lease Sale 184 that addresses marine mammal acoustics take issues. There were two other related biological opinions, the Multi-Sales Biological Opinion and the Eastern Gulf of Mexico Biological Opinion.
- December 2002 – MMS petitions NMFS for incidental take rulemaking
- March-April 2003 – NMFS publishes notice of receipt of MMS incidental take authorization petition; seeks and extends the comment period to April 16, 2003
- November 2004 – NMFS publishes notice of intent to prepare an EIS and to hold public meetings in December 2004.
- April 18, 2011 – BOEMRE (MMS's successor agency) submits revised incidental take petition.
- June 14, 2011 – NMFS publishes notice of receipt of revised petition from BOEMRE and request for public comment.

Industry Engagement

Regulatory Process

The Associations support the BOEMRE, on behalf of industry, petitioning the NMFS for incidental takes authorization of marine mammals under the Marine Mammal Protection Act (MMPA).

Development of Scientific Knowledge

The Associations and their members support the use of the best available science-based information in the development of regulations. Over the years, industry has spent millions of dollars to assist in gaining new knowledge about marine sound in the environments where we operate. The industry via consortiums and company initiatives has been active in contributing to the development of new, independent peer-reviewed science on the topic. Industry scientists and engineers have collaborated with academics and government agencies in the U.S. and around the world. As a result, the industry is especially well situated to offer comment on scientific and technical details that are central to the BOEMRE petition and ultimately to NMFS's own work on promulgation of a five-year rulemaking. In addition to providing funding, industry also engages in scientific forums in search of practical solutions. Below are a few examples where Industry participates:

Industry Research Funders Collation (IRFC): In 2002, a group of major U.S. oil companies and the International Association of Geophysical Contractors (IAGC) provided funding in support of the MMS Gulf of Mexico Sperm Whale Seismic Study (SWSS). It was during this time that the industry also started funding the development of a passive acoustic monitoring interface software called "PAMGuard". PAMGuard now provides a valuable tool to those within the marine mammal community who use this free software for marine mammal detection and surveillance. It has also been used successfully as the PAM software on many seismic surveys that utilized a PAM system.

OGP E&P Sound & Marine Life Joint Industry Program (JIP): Since 2005, the JIP has, and still is, contributing to the search for new scientific knowledge with respect to sound and marine life. The JIP is comprised of E&P companies and IAGC and is administered by the International Association of Oil and Gas Producers (OGP). Spending in excess of \$25M since 2005, the JIP has contributed to new science in the following areas (a) Sound Source Characterization and Propagation, (b) Physical, Physiological, and Hearing Effects, (c) Behavioral Reactions and Biologically Significant Effects, (d) Mitigation and Monitoring, and (e) Research Tools. Currently, a multi-million dollar/multi-year JIP project is being conducted offshore Australia, which seeks to better understand the potential impacts of seismic surveys on humpback whale behavior. This project is being co-funded by BOEMRE.

National Oceanographic Partnership Program (NOPP): For the last several years, industry has participated in various NOPP projects. For example, individual oil companies and the Sound & Marine Life JIP have funded projects in the areas of: (a) determination of animal density using passive acoustic monitoring; (b) providing support to Stellwagen Bank passive acoustic studies for the protection of right whales; (c) new satellite tag development, and (d) next generation passive acoustic monitoring systems (funded by API members).

Industry Principles & Position

The industry encourages proper rulemaking in accordance with federal regulations. During these past years, industry has supported and encouraged both MMS/BOEMRE and NMFS to

complete their work. The basis for the rule making should be premised upon best available science and considered alternative actions. To achieve this, the regulatory activity should:

- Accurately portray the nature and scope of industry activities.
- Accurately characterize acoustics and marine biology.
- Accurately portray the environmental effects of industry actions and consider these in the broader context of other acoustic sources and risks to marine life recognizing the effectiveness of mitigation measures, recognizing that exposure to sound does not necessarily equal a “take”.
- Assess the potential impact of industry operations using standard and accepted risk assessment approaches.
- Address uncertainty in a transparent, documented, reasonable and balanced manner.
- Progress the regulatory rulemaking.

Summary Assessment of BOEMRE Revised Petition

We have evaluated the BOEMRE revised Petition, employing the principles and positions outlined above. The industry appreciates BOEMRE’s efforts to revise the petition. The inclusion of new research results and information is positive, but incomplete. There are significant research results that were omitted on important topics such as stapedial reflex that indicates that some marine mammal species, including dolphins common to the Gulf of Mexico, have the ability to selectively reduce their hearing sensitivity. In addition, the fact that dolphin hearing sensitivity is predominately in the mid-frequency range while seismic sources are predominately a low-frequency sound source is not addressed.

Industry comments below will go into considerable detail as required to highlight specific technical issues. However, it is important to not lose sight of the overarching question: “Does the revised petition accurately characterize risks/impacts and ultimately provide a reasonable estimate of incidental takes?” We believe that while well intended, the BOEMRE application greatly exaggerates the estimated number of takes. Furthermore, BOEMRE presents a model-driven estimate of incidental takes that used conservative assumptions and limited data in a fashion that incorrectly implies a level of knowledge and precision that neither the science nor the model support. In so doing, BOEMRE in essence makes the “model” the “decision maker” removing common sense, context, agency discretion and ignoring widely accepted methods for characterizing risk and uncertainty. The Associations do not believe that “exposure equals incident takes.” Nor do the Associations take the position that BOEMRE must remedy all weaknesses in the AIM Model nor close every data gap before proceeding with the Application. The Associations do believe, however, that BOEMRE should explicitly and transparently acknowledge these uncertainties and apply reasonable discretion in its risk assessments recognizing that estimates of “takes” at present are imprecise and likely greatly overstated.

A common approach of validating impact assessments is to compare predictions with field observations. Yet, BOEMRE’s petition does not explicitly consider the government’s own stranding and Marine Mammal Observer (MMO) data and fails to explain the historical absence of observable physical or significant behavioral impacts from seismic activity on marine mammals. Given the level of scrutiny of the marine sound issue, the level of scientific inquiry/expense but absence of demonstrable impacts to animals over the last decade, it seems prudent to at least ask “What is the problem that demands so many resources?” Although technology has become increasingly sophisticated and better able to predict impacts,

no such impacts have been verified. The lack of a measured impact is a significant analytical gap and suggests the risk assessment conducted by BOEMRE has not been based on solid scientific analysis.

To understand how the risk assessment was overstated by what appears to be several orders of magnitude, one must examine the individual components: the data inputs, the layers of “uncertainty factor” that were added and finally the misuse of the various model components.

The industry comments provide (a) a high-level summary of issues that need attention, and (b) detailed recommended actions on acoustics, biology, acoustic thresholds, and use of the AIM model.

Summary Review of Application

- In our opinion, the Application does not properly consider past agency deliberations and scientific insights into differentiating diminutive sound exposure; short-term individual behavior effects; and finally population level effects as discussed in NRC 2005.
- Inaccurately characterized some industry activities and their acoustics emissions.
- Failed to characterize the important role seismic technologies bring in reducing drilling and other E&P risks.
- Omitted marine mammal observer and stranding data.
- In some cases, did not incorporate best available information on topics that have significant impact on the incidental take numbers including species population and density data; acoustic measurements, acoustic impact thresholds and new research on the hearing ranges of several species that would reduce the assessments of potential acoustic injury.
- Extrapolated marine mammal and acoustics data beyond acceptable limits.
- Inconsistent use and interpretation of marine mammal acoustic take thresholds, in particular, the treatment of recommendations made by an expert panel assembled by NMFS (Southall, et al. 2007) and, as a result fails to differentiate among various levels of impact by not adequately considering the variations in and differences among sound emission levels, received levels, individual animal hearing frequency ranges, short-term effects and behavioral effects that are biologically significant.
- Employed ‘conservative factors’ that have not been adequately disclosed, documented or linked to a scientific basis resulting in substantially inflated incidental take numbers.

Detailed Industry Comments

Industry Operations & Acoustics Characterizations:

- Section 1, page 1, according to industry experience, boomers, sparkers and chirpers are rarely used as sources in the GOM
- Section 1, page 2, 3-D line separations typically range from 300-600m, not 25-30 m as stated in the application. There seems to be confusion between receiver (streamer) line spacing and sail line spacing (which is the line on which the ship sails and thus is representative of the separation of the line in which seismic source arrays are towed). Array sizes used by oil and natural gas exploration and production industry also vary. In the GOM, seismic surveys have been

conducted with array sizes up to 8,000 in³. “The streamer array might consist of 6 to 8 parallel cables, each 3,000 to 12,000 m long, spaced 25 to 100 m apart. An 8-streamer array used for deep water surveys is typically 700 m wide.” (Section 1, page 2) Industry suggests that this is reworded to read “In current configurations, the streamer array may consist of up to 12 cables, each 3,000 to 12,000 m long, spaced from 25 to 150 m apart, depending on the sub-surface sampling required. A typical 10-streamer array used for deep water surveys can be up to 1,100m wide”

- Section 1, page 3 frequencies of acoustic transmitters used in OBS and node surveys are more typically 18-36 kHz range than the stated 9-13 kHz. In shallow water 35-55 kHz are more likely to be used. Some of the older systems, now being phased out, are 7.5-110 kHz.
- Section 2, page 4, BOEMRE’s application states that surveys can last from days to weeks to months. It should be noted that wide azimuth surveys with vessels towing long streamers, especially wide azimuth with multiple vessels which must be properly aligned, will have many hours during line turns where the source arrays are either silent or are activating the smallest source element as a mitigation device. The seismic sources are not continually activated during these surveys. In addition, the vessels are moving several kilometers per day so any localized disturbance is limited to a very short time period in any given geographic area
- Section 2, Table 2-5, page 9, the title should be expanded to include 3D high resolution in addition to 2D
- The acoustic modeling methodology described in Section 6 and Appendix A, used to estimate the number of marine mammals potentially ‘taken’ incidental to seismic surveys, is subject to both limitations inherent in the environmental modeling, acoustic modeling and quality of available data. This leads to an overestimation of the number of anticipated takes due to acknowledged computational limits and gaps in data for both the physical environment and marine mammals
- Section 7, page 29, “Seismic sounds are predominately low frequency (<200 Hz), though airgun arrays also produce energy at higher frequencies that may negatively impact some delphinid species”. The energy at higher frequencies is at a much lower source level and higher frequencies do not travel as far as low frequencies; therefore it is unlikely that any high frequencies produced by seismic arrays would result in physical harm or significant biological impact to delphinids (Richardson et al. 2011).
- Alternative technologies are mentioned in the revised petition as possible methods to minimize or reduce the amount of sound introduced to the water during seismic surveys (Section 11, page 31). The geophysical industry is currently researching and developing the methods described in Section 11 but as

mentioned previously, none of these methods are ready for widespread use on commercial seismic operations. It is difficult to predict future developments as there are several possible methods of reducing the impact of marine seismic sources on aquatic fauna. A few of these methods are described below:

- Further development of the seismic source element to reduce its high-frequency output;
- Reduction of the high frequency output of the whole array by staggering the activation times of the seismic source elements in the array so that the higher frequencies are removed by destructive interference;
- Utilization of smaller sources where this can be accomplished without compromising the image beyond usefulness;
- Utilization of vibratory sources instead of impulsive seismic sources that spread the emitted energy over a longer time and may be beneficial. They can also potentially be designed to emit fewer higher frequencies.

However, at present, none of these methods are a comparable, commercially available alternative to a tuned seismic source.

- While BOEMRE, in Section 1, briefly describes the benefits of the various categories of seismic surveys, it fails to adequately characterize the important role they play in reducing safety and environmental risks in the E&P operations, particularly in drilling operations. For example, in Section 1, Page 2, second paragraph, the Application notes "maximizing the success rate of exploration wells and minimizing the number of wells required to develop a field". In fact, the improvement of subsurface imaging as a result of technological advances in seismic data acquisition and processing have reduced historic industry practice of exploring with the drill bit, both in exploring for prospects and for the boundaries of a reservoir once it is discovered. And high-resolution surveys play a significant role in reducing risks associated with shallow hazards that, in the absence of such surveys, could lead to safety or environmental incidents.

Marine Biology Data Quality Issues

- BOEMRE did not utilize the most recent NMFS marine mammal stock assessment report (Waring et al., 2010). While this has no effect on the list of species present, it could change the best available information for numbers, seasonality, and geographic preference (depth and OCS region) impacting the incident take numbers. While use of the 2009 Stock Assessment Report (SAR) for individual species accounts (Section 4, Page 12) is an improvement on 2004 information, we suggest use of the 2010 SAR.
- Another potential concern is while BOEMRE is using NMFS sources for the species present (3) and more detailed accounts of those species (4), the model effort as detailed in Appendix A, states the U.S. Navy OPAREA Density Estimates (DoN, 2007b) are the best marine mammal density efforts available. The Navy effort was based on NMFS data - "NMFS was routinely consulted and provided much of the data..." - but a connection between the base LOA application account of species distributions and what was used for modeling is

missing. It is unclear whether the Navy density estimates are consistent with the most recent NMFS information?

- Some data on individual species biology data appear to be incorrect or obsolete. In some cases this information deals with the habitat, range or seasonal presence and therefore has important implications for misstating exposure to industry sound sources.
 - Baleen whales
Wursig et al (2000), in their book on Gulf of Mexico marine mammals, established that few baleen whales are seen here and only one species (Byrde's) is considered a resident. The essential lack of baleen whales (low-frequency specialists) in the Gulf is significant for species at potential acoustic risk. It would be useful to verify this situation with more recent citations or perhaps personal communications with a NMFS expert.
 - Killer Whales
Contradictory wording exists for distribution (at Page 12). While Reeves et al (2002) may state killer whales [across all clans] are not limited by such features as water depth, killer whale sightings in the GOM are all in deeper water. This needs to be better explained. In general, the use of Reeves et al. (2002) for generic statements on world distributions of marine mammals, while exceptional information for 2002, is often dated for 2011.
 - Short-finned Pilot Whale
The short-finned pilot whale (Page 15-16) is an example where more recent population declines are a concern, although not specific to the GoM. Nevertheless this species has particular concerns that dated references fail to address.
 - Sperm Whale
Recognizing both their iconic and ESA-listed status in the GoM, both regulators and industry have collaborated in research to better understand potential effects if any of seismic operations, on sperm whales.

MMS, with significant cooperation from NMFS, NSF, and industry conducted a series of controlled exposure experiments (CEEs) using seismic source arrays and tagged sperm whales in the Gulf of Mexico (MMS 2008). The initial account of CEE results and context of this effort within the broader Sperm Whale Seismic Study (SWSS) are found in this MMS Final Report. Subject to external peer review, the published CEE results are found in Miller et al. (2009) and as part of a review of CEE methodology in Tyack (2009).

SWSS refuted earlier speculation (Mate, 2004) that seismic surveys would disrupt sperm whale vocalization and displace whales over large-scale

areas of the GOM (MMS 2008; Richardson et al. 2011). The CEE effort focused on the behavior of individual sperm whales before, during, and after exposure to a seismic source. Over two seasons of effort, 8 sperm whales were tagged and exposed to seismic sources at distances calculated not to exceed 160 dB re: 1 μ Pa (rms). The most pronounced response was one tagged whale, already resting at the surface, delayed diving until minutes after the seismic source ceased operation.

The response by the sperm whales was mixed, limited, and short-term. While not discussed in these papers, there were observations of sperm whales' behavior disturbances due to tagging activity itself. Several dive cycles were allowed for the tagged whale to return "to normal" before exposures, in terms of the experimental design. That sperm whales often completely abandoned normal dive patterns after tag attachment or breach provides indications of what more pronounced disturbance responses can be and put the effects of exposure to seismic surveys in context.

The BOEMRE as the lead-agency for cooperative research on GOM sperm whales should update the revised petition to provide more recent information for sperm whale distribution obtained through results from SWAMP and SWSS studies. The 2004 citations concerning sperm whale concentrations off the Mississippi River delta and speculation on upwellings has been very significantly updated by SWSS results and need to be better and more accurately addressed. Use of new density data will likely show the highest density would be in waters approximately 1000 meters and deeper.

– Bottlenose dolphins

These are the only species of marine mammal expected in shallow waters (< 200 meters depth). One is less likely to see Atlantic spotted dolphins in shallow waters. The species accounts (Section 4, Page 19) state both are common in shallow water, contrary to the far greater expectation to see only bottlenose dolphins in coastal waters. For shallow-water operations, only one cetacean species would typically be subject to seismic sound exposure and any potential risk.

Hearing Sensitivity

The primary sense for cetaceans (whales and dolphins) is hearing. Cetaceans have evolved to both use sound underwater and also to protect their hearing mechanisms. Sperm whales click the majority of their lives. The typical sperm whale deep-dive navigational click has an estimated near-source sound intensity up to 236 dB re: 1 μ Pa (rms) and at least 210 dB re: 1 μ Pa (rms) with a click frequency that centers around 15 kHz (Mohl et. al 2003). Therefore, the source level of sperm whale clicks is above the current NMFS Level A noise exposure criteria of 180 dB re 1 μ Pa (rms).

Recent research by Supin et al. (2008) has revealed methods to measure the hearing of whales and dolphins while they echolocate. The researchers found that the false killer whale has a very active hearing control process – stapedial reflex. The false killer whale changes its overall hearing by 20 dB depending on whether it is searching, or has found, a target (Supin et al., 2008). Furthermore, the whale actively controls what it hears of its own loud outgoing signal, the return echo and its overall ambient hearing during echolocation (Supin et al., 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010). Of the 85 species of whales and dolphins it seems possible that the 73 echo-locators (including Sperm Whales) have the capability to control their hearing using stapedial reflex.

Sound Exposure & Acoustic Thresholds

The BOEMRE revised petition request would be improved by a fuller discussion of the history and underlying difficulties in establishing acoustic criteria and thresholds. If the petition had done so, industry believes that the state of knowledge, level of precision in knowledge, and levels of uncertainty could have been more explicit and the agency's judgments to address uncertainty made more transparent. This would have led to an improved, more transparent approach than the potential overuse of an imperfect predictive model that cannot replace judgment and context in decision-making.

Background

The Marine Mammal Protect Act (MMPA) was created to protect marine mammal populations from depletion or extinction. Then and now the largest known risk to marine mammal populations is the annual loss of cetaceans due to fisheries bycatch that has been estimated to approach 300-400 thousand animals per year (Moore et al. 2009; Read et al. 2006).

When the MMPA and ESA were initially crafted, acoustic takes were not a consideration. The decision to apply the MMPA and ESA for acoustic impacts and the various interpretations required for implementation of that decision resulted in considerable uncertainty due to technical data gaps and regulatory policy. Central to that decision was the notion that “exposure to sound equals harm whether or not there is harm. **The Associations then and now strongly oppose a regulatory approach premised on this notion that exposure equals an incidental take.**

Nonetheless, the regime of Level A “physical injury” incidental takes and Level B “behavioral” takes was applied. Physical injury -- Level A – was judged to occur if either mortality or a permanent threshold shift (PTS) occurred.

In 1995, NMFS established for Level A takes an underwater "do not exceed" criteria of 190 dB re: 1 μ Pa (rms) for most toothed whales (dolphins) and 180 dB re: 1 μ Pa (rms) for baleen whales, sperm whales, and pygmy/dwarf sperm whales (*Kogia* spp.).

In June 1997, a panel of experts, the High Energy Seismic Survey (HESS) team retained the 180 dB re: 1 μ Pa (rms) limit as the threshold for potential injury (Level A). At the same time NMFS modified the 180 dB re: 1 μ Pa (rms) exposure criterion to apply to all cetaceans while 190 dB re: 1 μ Pa (rms) was to be used for seals. At that time and since, there was greater confidence in the levels set for Level A (physical injury) due to the fact that the

threshold for physical injury was determined to be Temporary Threshold Shift (TTS) and was measurable. Sound exposure levels established for disturbance or harassment (Level B) was highly debated because of the difficulty in knowing when an observed behavior resulted from exposure to sound or was merely a natural response or a response to some other factor in the environment.

After increasing public attention to the potential impact of marine sound, the Marine Mammal Noise Exposure Criteria Work Group (the Southall Work Group) (Southall et al. 2007) was formed in the early 2000's to review the body of scientific evidence and recommend thresholds that regulators could employ. The Southall Work Group examined the prior Hess work and determined that those levels were "precautionary estimates" below which physical injury was considered unlikely (Southall et al. 2007). After reviewing all the available research, the Southall Work Group proposed a threshold for Level A injury of 230 dB re: 1 μ Pa (peak) (flat) (or 198 dB re 1 μ Pa²-s, sound exposure level). The Southall Work Group also repeatedly stated that precaution factors had also been applied in creating its own new proposed criteria.

Estimates of Potential Level A and B "Takes"

As noted, it is not clear from reading the Application what thresholds are will be used. It is important for the Application therefore to clearly define what constitutes a take and why and what thresholds will be utilized in the rulemaking.

Level A

The growing scientific consensus is that seismic sources pose little risk of Level A takes (Southall, 2010; Richardson et al. 2011). Southall and Richardson recommended BOEMRE a Level A threshold, 230 dB re: 1 μ Pa (peak) (flat) (or 198 dB re 1 μ Pa²-s, sound exposure level) The NRC's expert panel assessment (NRC 2005) and further review as discussed by Richardson et al (2011) also supports the Associations' position.

Level B

With respect to the establishment of thresholds for the Application, the Associations note that while some aspects of the MMS 2004 PEA could be updated with new information, the basic premise of the 2004 effort has remained true (see Richardson et al. 2011 for 2004-2011 updates:

A key point is that almost all impacts of seismic surveys have been inferred or assumed by implication rather than observed. There have been no documented instances of deaths, physical injuries, or auditory (physiological) effects on marine mammals from seismic surveys. Behavioral responses have been observed in many instances, primarily in mysticetes [baleen whales]. However, the biological importance of such behavioral responses (i.e., to the individual animals and populations) has not been determined. (page III-9, MMS, 2004).

The level of sound exposure that will induce behavioral responses may not directly equate to biologically significant disturbance; therefore additional consideration must be directed at response and significance (NRC 2005; Richardson et al. 2011). To further complicate a determination of an acoustic Level B take, the animals' surroundings and/or the activity

(feeding, migrating, etc.) being conducted at the time they receive the sound rather than solely intensity may be as important for behavioral responses (Richardson et al 2011).

The Southall Work Group also questioned the relevance of the 160 dB re: 1 μ Pa disturbance criterion noting that thresholds for odontocetes and pinnipeds exposed to pulsed sounds is not at all well-established ..." (Southall et al. 2007, Page 417).

Further, the Marine Mammal Noise Exposure Criteria Work Group recognized that a difference existed between "a significant behavioral response from an insignificant, momentary alteration in behavior." (See also Richardson et al. 2011). The work group went on to propose that "Consequently, upon exposure to a single pulse, the onset of significant behavioral disturbance is proposed to occur at the lowest level of noise exposure that has a measurable transient effect on hearing (i.e., TTS-onset). We recognize that this is not a behavioral effect per se, but we use this auditory effect as a de facto behavioral threshold until better measures are identified.

Factors Impacting Thresholds

Other considerations should be recognized by BOEMRE in establishing thresholds:

- The biological significance of sound may also depend more so on how long the sound persists (Richardson et al. 2011). BOEMRE fails to allow for the fact that 3D seismic surveys (most common) are typically acquired in a racetrack pattern resulting in lower chances of an individual animal being exposed to loud sounds for extended periods of time. In other words, given that the seismic vessel is moving in and out of a localized area and the fact that animals are believed to avoid vessel traffic and seismic sounds, cumulative sound exposure is again likely being overestimated. Seismic operations are most often in timescales of weeks and reduce the possibility of significant displacement since they do not persist in an area for an extended period of time. However, little indication of area-wide displacement exists.
- The revised petition does not consider the fact that many animals avoid vessels regardless of whether they are emitting loud sounds and may increase that avoidance distance during seismic operations (Richardson et al. 2011). Therefore, it should be a reasonable assumption that natural avoidance serves to provide another level of protection to the animals.
- As previously noted, the Application is unclear about what constitutes an incidental taking. Given the MMPA defines Level B takes in the context of behavioral change, not in the context of sound level exposures, or RMS Sound Pressure Levels. It is debatable whether behavioral changes are dose-responses or context-responses. There are also indications that some animals change their behavior in the presence of RMS Sound Pressure Levels of 160 dB or lower; in other cases of exposure to sounds of 160 dB (and higher) there is no evidence of behavioral change. It is neither logical nor reasonable to assume that

every exposure to 160 dB or higher results in a behavioral change of biologically significant impact and that change would represent a Level B take.

- There is also mounting scientific evidence that behavioral reactions are species dependent (Stone and Tasker, 2006) and can vary due to biological and environmental context (Wartzok et al. (2004), Frost et al. (1984) vs Finley et al. (1990), (Richardson et al., 2011; Miller et al., 2005), (Richardson et al., 1999). Most behavioral studies conducted to date have not recorded the received sound pressure levels nor is it clear that sound pressure level (rms) is the best measurement to use for behavioral studies (Southall et al. 2007). In other words, there is not enough scientific evidence to provide a convincing argument that 160 dB should be used as a behavioral “take” criteria. In the base case, it is highly likely, just as the case where 180dB was previously used, that 160dB is overly cautious and results in an exceedingly high number of “takes”. Further, as acknowledged by BOEMRE in Section 6, page 24, “Those animals within calculated isopleths of sound above 160 dB re: 1 μ PA (rms) are considered a take.” This basic rationale (independent of uncertainties in numbers) also likely overestimates actual take numbers (exposure of an animal to a sound is not necessarily equivalent to the animal being taken).
- With reference to BOEMRE’s application (Section 5, page 23), “Since it remains unclear that the pulsed, low-frequency sound source resulting from airguns has actually caused injury to marine mammals in open water” (NRC, 2003) or that “marine mammals would not deflect away from sound intensities that could result in injury (MMS, 2004), the potential for injury is considered unlikely, but exposure to 180 dB re: 1 μ PA rms or greater is possible.” In the paragraph beginning at the end of page 22, the Associations suggest that BOEMRE’s revised petition would benefit from similar acknowledgment for Level B that significant behavior effects are also unlikely.

Industry does not believe 180 dB is the correct threshold for potential injury from multi-pulsed seismic sources. The potential for injury is close to nonexistent at this level. We believe a similar disclaimer of “significant behavioral changes resulting from exposure to sound levels of 160 dB re 1 μ Pa (rms, unweighted)” should be inserted in the application text in this section.

- Section 6, page 23, states, “This guideline [referring to the 160 dB guideline] does not consider the frequency component and nature of the sound source nor the hearing sensitivities of different cetacean species.” Industry recognizes, as does BOEMRE and NMFS, guidelines cannot address every specific detail and factor short of specific guidelines for every specific action. Southall et al (2007) went to great effort to define functional groups in terms of sound sources and marine mammal hearing specialists. Industry is concerned with the use of the antiquated 160 dB guideline for Level B take estimation and, to a great deal, the inability to define a more reasoned criterion rests with an inability to document and quantify marine mammal responses to known sound levels and, more so, what response constitutes a biologically significant effect (NRC 2005). The

Associations strongly encourage NMFS and BOEMRE to consider the frequency component, nature of the sound source, cetacean hearing sensitivities, and biological significance when determining what constitutes a Level B take.

- The 198 dB SEL criterion is mentioned and apparently applied in Appendix A, so it is likely that the Level A takes estimated in Appendix A and quoted in BOEMRE's Table 6.2 (p. 27, left side) were in fact calculated appropriately. However, certain column headings and Tables are unclear. Specifically, the column headings of Table 6.2 and the corresponding Table in Appendix A (Table A-21, p. 77) both refer to an SEL criterion of 215 dB, not 198 dB. Southall et al. proposed a 215 dB SEL criterion as an injury criterion for exposure of cetaceans to non-impulse sounds, and that is not appropriate for seismic surveys with pulsed seismic sources. For those, the appropriate injury criterion is 198 dB SEL. It is likely that Appendix A and the AIM modeling summarized in the left half of Table 6.2 actually did use the appropriate 198 dB SEL criterion, as stated on p. 60 of Appendix A (Table A-19), but the 215 dB SEL value listed in the column headings of the Table A-21 and Table 6.2 is confusing. In the unlikely event that the calculations in Appendix A (and summarized in the left side of Tables A-19 and 6.2) did use the 215 dB SEL criterion as stated in the column heading, then the Level A ("injury") estimates on the left side of Tables 6.2 and A-21 would have been significantly underestimated, and corrected predictions of "Level A takes" would be even more problematic than the values shown.
- The above statements, made in the application, in conjunction with the previously described limitations of the acoustic modeling make it clear that the estimates of potential Level A and B 'takes' in Tables 6-1 and 6-2 are large overestimates. NMFS will need to address this fact of overestimated take numbers in its DPEIS and Draft MMPA Rulemaking. The overestimated take numbers should not be accepted '**as is.**' As mentioned earlier, all of the assumptions in the model and the problems with the current NMFS guidelines for Level A and B takes need to be clearly explained and addressed.
- The BOEMRE request (p. 24, bullet #2) does not adequately describe Southall et al.'s proposed cumulative energy criterion. Southall et al. indicate that, for impulse sounds, any cetacean exposed to either a peak pressure ≥ 230 dB re 1 μ Pa or a cumulative sound exposure level (energy) of 198 dB re 1 μ Pa²-sec might incur auditory injury. BOEMRE's request (on p. 24) does not mention the second of these dual criteria, which is the one that will almost always (if not always) be the determining factor.
- The BOEMRE request does not make clear whether "M-weighting", as proposed by Southall et al. (2007), was applied in calculating the estimated "takes". Appendix A indicates (p. 60, Table A-19) that the Level A take estimates using the 198 dB (?) SEL criterion did incorporate M-weighting. The phrase "use standard/traditional value" in Table A-19 might mean that M-weighting was not applied when working with those old rms criteria. M-weighting may be justified, as explained by Southall et al. (2007) and to some degree in Appendix A, and

would in fact still be precautionary for both Level A and Level B calculations. That point could have been emphasized in BOEMRE's request, as a further reason why the existing take estimates are overestimates (particularly if no M-weighting was applied). It is important to advance these arguments because, as we understand it, NMFS has not yet publically accepted that M- (or similar) weighting should be applied when estimating takes during seismic surveys. Even if M-weighting was not applied when calculating the numbers of cetaceans that might be exposed to 160 and 180 dB re 1 μ Pa (rms), it was applied when Level A takes were re-calculated based on the 198 dB (?) SEL energy-based criterion, and the appropriateness of M-weighting need to be emphasized to justify acceptance of those estimates rather than the much larger 180 dB (rms) estimates.

Uncertainty & Layering Precaution / Conservative Factors

Having injected precaution during the noise criteria development stage and once again at the AIM modeling stage coupled with acknowledged gaps in input data about marine mammal populations, distribution, abundance and behavior, it is highly likely that the number of "takes" have has been significantly overestimated.

Therefore, the Associations urge BOEMRE to examine this process and make publically available all scientific uncertainty, assumptions, and precautionary factors applied that are associated with each step of this process such as: 1) estimates of seismic activity, 2) source sizes and characterizations, 3) underwater sound propagation, 4) population estimates and densities of marine mammals, and noise exposure criteria, and 5) marine mammal behavior. The reality is that the model does not reduce but rather expands the rate of error. The greatest risk is that models are not used to provide insight to aid managers in risk assessment decisions but rather are themselves cast as risk assessors. The Associations strongly object to this approach given the lack of precision in the data and the model.

The layering of precaution on top of precaution in every step of the process results in a large overestimate of the numbers of 'takes.'

In Section 6, page 24, the application states, "this basic rationale (independent of uncertainties in numbers) probably overestimates actual take numbers (exposure of an animal to sound is not necessarily equivalent to the animal being taken)." The word "probably" should be deleted. The take estimates in this document are largely overestimated, for several different reasons. For example, the document purports to equate exposure to certain sound levels with a take and uses conservative assumptions within the acoustic modeling.

The above statement regarding the overestimate of take numbers should be highlighted in the application text and on Tables 6-1 and 6-2. Also footnoted on Tables 6-1 and 6-2 should be all the assumptions and data gaps in the model as described in Appendix A. We strongly urge NMFS to address the use of conservative assumptions in the model and how that affects the 'take' estimates. It is imperative that if this model is used, it is clearly explained that it will result in overestimates of takes and therefore, that current mitigation

and monitoring requirements are most likely more than adequate to minimize any ‘takes.’” (See page 24, “Required mitigation and monitoring measures...are therefore considered conservative.”)

Modeling Issues:

Industry has identified problems with the (a) acoustic modeling and (b) the AIM Model

Acoustic Modeling

- Selected input parameters/variables could affect the results:
 - The 4,550 cubic inch array used in the acoustic modeling could be considered an average for 2D and perhaps narrow azimuth 3D surveys. In recent years and especially with deep-water WAZ surveys, array sizes have increased. Generally, they now fall between 5000 to 8000 cubic inches.
 - Typical source modeling packages in the industry are only calibrated and therefore only accurate in the seismic band that is below ~200 Hz. This is true of the ‘Nucleus’ package, which is an industry standard. In BOEMRE’s application, modeling of up to 1000 Hz was used so there will likely be significant uncertainty in this extended band. Of equal or greater importance is that much of the useful seismic bandwidth (<50Hz) was not included due to model limitations.
 - The OBS model was run using atypical (one of the most dense) OBS acquisition methods. Source effort was set at a 12.5 meter source activation interval and 6-second record length. In order to maintain proper recharging of source elements with this short source interval would require smaller source arrays than used in the modeling.
 - On standard 3D surveys, AIM’s model estimate of survey duration was almost 45% longer compared to a similar survey modeled by a geophysical company (an IAGC member). We can only assume that the model is utilizing a lower capacity 3D vessel; however, if a modern high capacity vessel was used, the exposure time in the survey area would be substantially decreased thus resulting in fewer ‘takes.’
- Not only does the model have limitations because of the uncertainty in so many of the input variables and parameters, but in almost all instances the modelers decided to use conservative estimates/assumptions. Once again the layering of precaution on top of precaution in every step of the process results in a large overestimate of the numbers of ‘takes.’ Below are just a few examples from the acoustic modeling section (Appendix A) which illustrate the use of conservative inputs to the model:
 - “A conservative (precautionary) estimate of this offset between TTS and PTS thresholds, when sound exposure is measured on a sound exposure

- level (SEL) basis (received energy levels), is to add 15 dB to the TTS value for impulsive sounds” (page 8, Appendix A)
- “...but also tended to err on the conservative side by using those parameters which resulted in a lesser values of transmission loss (i.e., a higher received level at the modeled animals)” (page 23 Appendix A)
 - “Therefore, a conservative value of 0.1 s is used for the signal duration for this analysis...” (Page 10, Appendix A)
 - “These seasonal wave height data were applied conservatively (i.e., producing the least TL) for the acoustic propagation modeling.” (Page 31, Appendix A)
 - “This is a conservative assumption, given that the marine animals that were simulated during the AIM portion of the modeling probably have some directivity for any frequency of sound that they can perceive...” (Page 32, Appendix A)
 - “In most cases, this represents a higher density of animats in the simulation (0.1 animats/km²) than occurs in the real environment...This approach should be considered moderately conservative in terms of allowing for more prolonged exposures than would be expected from species with a lower residency factor.” (Page 55, Appendix A)
 - Additional overestimating occurs within Appendix A such as the assumption of perfect omni-directional receivers (page 32) and the use of winter SVPs to calculate transmission loss (page 33)

AIM “Model” Issues

Use of the AIM model is integral to the BOEMRE assessment of seismic operational impacts on marine life and the mechanism used to develop the number of incidental takes in the revised petition. Unfortunately, the revised petition neither disclosed nor it appears corrected weaknesses identified during the 2006 NOAA contracted external review of the AIM Model conducted by the University of Miami Independent for Peer Review (Miami Peer Review):

- AIM is incorrectly portrayed in the Application as a model. The Miami Peer Review correctly judged that AIM is not a model but rather a “software package” that integrates various sub-models, i.e. acoustic and environmental models. (At page 1)
- AIM does not meet the criteria of the U.S. agencies own minimum standards for models, (At page 1). The Miami Peer Review panel agreed that the use of AIM might lead to models that will meet the Council for Regulatory Monitoring (CREM) guidelines. However, such models, at this stage, would need to be evaluated on a case-by-case basis. There has been no such case-by-case evaluation including use by BOEMRE in its attempt to use AIM to calculate seismic incidental takings for this action.

The Miami Peer Review assembled by NOAA itself noted that it could not agree that AIM met CREM’s requirements (CREM Guidelines at Page 1).

This is not surprising as there were identified problems with both validation and verification. On validation, the review panel noted that AIM had not been validated against marine mammal behavior. On validation, the review panel suggested that AIM should be validated against other government models including the Effect of Sound on The Marine Environment (ESME), a software workbench developed by the Naval Research Laboratory. On verification, issues were identified with the manner in which the AIM builders had verified and documented the accuracy of its code.

- AIM results are neither precise nor 100% accurate. AIM at best is an effort to create a mechanized approximate answer. We believe no one knows its accuracy. If AIM's accuracy is known, then a standard error (+/-) should be reported for each of the estimated 'take' numbers. The panel noted the absence of uncertainty tests (At Page 1).

"The reliability of AIM to assess the exposure hazard of marine mammals to anthropogenic sound is more limited by the realism of the animate engine module of AIM than the sound propagation modules ... animal behavior is far more complicated than behavior of physical systems." (Getz 2006).

"The core weakness in assessing impacts of sound is the lack of knowledge of marine mammal populations. This will improve in the coming decades but policy makers must be aware of the great uncertainty in this area." (At Page 8).

"... the animal animats are unlikely to behave anything like the real systems because ecological and sociological components of the behavior of individuals are ignored" (Getz 2006). (At Page 11)

- AIM alone is not appropriate for regulatory decision-making. The Associations believe it is a misuse of AIM to create and publish what seems to be highly precise incidental take numbers given the acknowledged limitations in both the mechanics of the model and the data that feeds it. If BOEMRE and NMFS proceed with the use of AIM to create take numbers as presented in the petition, then all of the limitations, assumptions and potential for error/uncertainty (as noted above) need to be clearly explained and addressed in the text of the application in the same section where the take numbers are presented. How these limitations, assumptions and uncertainties affected the 'take' estimates (large overestimate) need to be explained. NMFS needs to consider all of these factors in its analysis of the modeling approach and estimated take numbers in the DPEIS and Draft MMPA Rulemaking.

"There was general agreement that the best available data and models have been incorporated into AIM. However, it was again noted, that the "best available" is not very good in a number of areas." (At Page 9). "The behaviors of real animals ... are, for the most part, not well enough

empirically established to have a theoretical basis for implementation” (Getz 2006) (At Page 9). “These adaptations are largely limited by the lack of detailed behavioral data on free-ranging marine mammals.” (Thomas 2006).

- Adequate sensitivity and uncertainty analyses were not performed. Two panelists (modeling specialists) familiar with statistical modeling in broad biological applications succinctly stated that adequate sensitivity and uncertainty analyses were not performed (Getz 2006). The acoustic expert noted, with regard to providing error bounds on estimates, “that the acoustic modeling community has historically not graduated to this stage either ...” There are few restrictions within AIM which would prevent suitable analyses being performed. However, it is abundantly clear that these analyses have not been performed in applications to date. (At Page 11-12)
- Critical improvements were recommended (At Page 12-14): Further testing and validation was strongly encouraged. BOEMRE should ensure that AIM performance is compared with a software platform such as ESME over a set of exercises that covers the full range for which AIM is designed to provide assessments (Getz 2006). (At Page 13)

If the model is to be used for particularly important policy decisions, an investment is needed to benchmark the code and provide transparent documentation that demonstrates better benchmarking has been done. (Porter 2006 at Page 13)

Additional work was recommended in 2006 but it is not clear as a proprietary sourced model/code whether these steps were taken. Sensitivity studies were recommended to provide error bars on model predictions. Getz (2006).

The Associations agree and note given this comment that the single species incidental takes numbers should be revised to ranges that reflect the quality of the data, quality of the model and a statistically sound uncertainty analysis. Further, it was recommended by the review panel that critical output should be reported minimally in terms of both averages and confidence intervals. (At Page 13). Finally, the sensitivity of key measures, such as Level A and B takes, to the most uncertain or speculative parameters in the model should be reported. (At Page 13)

Other AIM Issues

There are other issues associated with the way the AIM Model is configured and used:

- It appears that the AIM calculations did not allow for active mitigation measures when the cetaceans were sighted within 500 meters (or some other mitigation distance). It is not clear whether there was any provision for any species of cetaceans. In some other applications of AIM to seismic surveys, allowance for shutdowns has been incorporated, and that reduces the number of predicted Level A takes.

- It would be helpful if the modeling report included specific information about the predicted received levels (both “rms over pulse duration” and SEL) as a function of distance, depth and aspect. Appendix A includes considerable discussion of the Tolstoy et al. (2004, 2009) studies that measured such values for two airgun array designs operating at various water depths in the GoM. However, we did not find specific predictions of the predicted received levels and SEL values for the assumed standard industry airgun array. That information must have been used in the process of estimating the “takes” summarized in Tables A-20 and A-21. That information is critical in developing or assessing any proposed mitigation strategy.
- Appendix A (p. 50) indicates (on p. 50, paragraph 1, 2nd last sentence) that the AIM runs did not allow for avoidance responses by cetaceans approached by the operating seismic sources. It is well established that many (not all) cetaceans exhibit some avoidance upon close approach by an operating seismic source. It would be difficult to allow quantitatively for this, given the lack of specific information about avoidance behavior (and the proportions of cetaceans exhibiting avoidance) in relation to distance from seismic sources, received sound levels, and other circumstances. However, not including any such allowance means that numbers of cetaceans exposed to high-level sounds (e.g., ≥ 180 dB re 1 μ Pa rms or especially ≥ 198 dB re 1 μ Pa² · sec) will be overestimated.
- The Level A takes estimated based on the Southall et al. criterion (presumably ≥ 198 dB SEL) are based on accumulating SEL over the full duration of each "exercise" [simulation], according to p. 58 (bottom). Those assumed "exercise" durations varied from 3,528 to 16,632 sec (2.45 to 11.55 days), but most often were 10,400 sec = 7.2 days (Table A-13, p. 51). Southall et al. can be read as suggesting that the accumulation should be limited to 24 hours, assuming that (with typical variability in exposure over time during a seismic project) the accumulation should reset to zero after no more than 24 hr because of auditory recovery. If that is appropriate, the SEL exposure estimates in Appendix A are higher than would occur if the “24-hr rule” were applied. However, when seismic operations are confined to a small area and received levels for an animal in that area never diminishes to low or zero values during the operation, the “24-hr rule” may not be appropriate. In that case, received levels might not diminish (during the operation) to low enough values for long enough for auditory recovery to occur. In any case, the approach in Appendix A would appear to be precautionary in this regard.

The simulation durations in Appendix A for some survey types are somewhat arbitrary and do not correspond to the full duration of the survey as described. For example, for the assumed 3-D survey, the AIM model was run for a 100 × 4.8 km area rather than the 100 × 24 km area that was assumed to be typical of a 3-D survey. Correspondingly, the model was run for a 7.2 d period rather than the 36.7 d period said to be necessary for the full survey.

This would be precautionary if the SEL exposure can be assumed to reset to zero each day, or at least at intervals <7.2 days, which is reasonable. However, it would be non-precautionary if exposure really should be accumulated over the full duration of the survey. The implications of the assumed survey durations do not appear to be addressed in the Appendix or in the main BOEMRE application.

- The assumed survey patterns for each of the five categories of seismic surveys (p. 52–54 of Appendix A) give no information as to the assumed sequence of lines (racetrack vs. sequential), or on the assumed source condition during line changes (silent, mitigation gun, full array). These uncertainties in assumptions probably do not matter much if one accepts the validity of accumulating SEL across the full duration of the simulation, but might matter if the accumulation were limited to 24-hour (or similar) periods.
- Table A-19 makes clear that M-weighting was applied when estimating SEL exposures, but it is unclear as to whether M-weighting was applied when calculating estimated numbers that would be exposed to ≥ 180 and ≥ 160 dB re 1 μ Pa (rms over pulse duration).
- Appendix A does not explicitly state which species of cetaceans were assumed (when applying M-weighting) to be low frequency, mid-frequency, and high frequency species. In particular, it would be helpful to understand whether pygmy and dwarf sperm whales (*Kogia* spp.) were treated as high-frequency species. In some early pre-publication presentations of the then-proposed Southall et al. approach, *Kogia* spp. were considered to be mid-frequency species, but in the final Southall et al. (2007) paper, they are considered high-frequency species.

Recommendations:

- BOEMRE clearly define what constitutes a take and why and what thresholds will be utilized in the rulemaking
- BOEMRE adopt as its Level A threshold the Southall recommendation of 198 dB re 1 μ Pa²-s, sound exposure level)
- BOEMRE should for consistency strongly consider adoption of the Southall guidance regarding the distinction between a momentary behavioral reaction and a significant behavioral reaction in establishing its Level B threshold.
- BOEMRE should recognize that sound exposure does not necessarily equal takes. "The basic rationale (independent of uncertainties in numbers) probably overestimates actual take numbers (exposure of an animal to a sound is not necessarily equivalent to the animal being taken)." (Page 24 of application)
- If NMFS accepts BOEMRE's application as is, with the current estimated take numbers, NMFS needs to provide a comprehensive, detailed explanation of all the limitations, assumptions and uncertainty contained in the AIM model which therefore result in an overestimate of incidental takes.

- In the BOEMRE application it should be clearly stated and explained that the approach currently used to estimate takes grossly overestimates takes; therefore, because of this large overestimate which will not be realized in actuality, any recommended mitigation measures should be designed to minimize the actual potential ‘takes’ and not the overestimate.

We appreciate the opportunity to provide you with these comments.

Sincerely,



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Sarah L. Tsoflias, IAGC



Dan Naatz, IPAA



Michael Kearns, NOIA



Albert Modiano, USOGA