Oral Testimony
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Honorable Members and Staff: my name is Dr. Bob Gisiner, I am the Director of Marine Environmental Science and Biology for the International Association of Geophysical Contractors.

However, I am here today to speak to you as a scientist, with more than 40 years of scientific expertise in this field, including my most recent role as a member of the Sound and Marine Life Joint Industry Program, a program of independent scientific research funded by members of the offshore energy industry.

Thank you for this opportunity to provide you with some information about the sound generated by marine seismic surveys and its environmental effects.

First, a little on my background and expertise. I have a Ph.D. in Biology from the University of California, and have been actively engaged in cutting edge research in marine bioacoustics for over 40 years.

In 1993, I was invited to lead a newly-formed US Navy research program at the Office of Naval Research on the effects of sonar and other sound sources on marine life, a program that to this day continues to lead the world in research on this subject.

From 2010 until my retirement in 2014, I worked with the Chief of Naval Operations Environmental Command (CNO N45) at the Pentagon to implement a policy and environmental compliance plan based on the scientific knowledge generated by the ONR Marine Mammal program; a legacy of responsible environmental stewardship without loss of Navy mission readiness of which I am very proud and for which I was awarded the Navy Meritorious Civilian Service medal.

My service to our nation and its marine environmental stewardship goals also includes a term of service between 2006 and 2010 as the Scientific Program Director of the US Marine Mammal Commission.

Following my retirement from federal service in 2014 I was invited to assist IAGC with a similar program of research and application of the science to responsible environmental compliance practices, including participation in the Joint Industry Program of research. As a newcomer to this industry, my perspectives may be of help to others who are also new to the geophysical industry, its technologies and its practices.

I will start by stating categorically and confidently that there is at present no scientific support for statements that seismic sound kills or injures animals, causes them to beach themselves or disrupts their behavior to the extent that it affects the health and well-being of the individuals or the populations of which they are a part. This does not mean that we will not continue to actively search for possible undetected risks through our support of independent, third-party research, or that we will reduce our diligence in monitoring, mitigation and documentation of our activities and their environmental effects. It does mean that speculations of what could, might, or may potentially occur will be subjected to the same high standards of scientific verification and validation that would be expected of our own industry-funded research.

Let's start with some scientific information about seismic sound sources or air guns. The term gun can be misleading; there is no explosion or "firing" of air. The compressed air is released in a bubble around the source through several ports. This can best be visualized through a video on the IAGC website: the link is provided in the supporting materials accompanying this testimony. The air inside the source is compressed to the same pressure as a scuba tank or a household pressure washer and when released, the expanding bubble produces sound. The largest sources hold a volume equivalent to a one

or two liter soda bottle, and a full array of sources would have a compressed volume equivalent to a full-sized to mini-sized refrigerator. This is clearly not a sound source equivalent to 100,000 jet planes or an atom bomb, as some have claimed.

Current claims that seismic sound kills, injures or causes the beaching of marine mammals, fish or other species are speculation and are not supported by the available scientific evidence. Recent research has in fact shown that the sound exposure threshold at which some small hearing loss might occur would be greater than 210 decibels of total energy (SEL). That is equivalent to the cumulative sound energy from ten consecutive seismic air pulses at a distance of less than 100 yards from even the largest arrays.

Current regulatory thresholds of 180 dB SEL are thus clearly overestimating risk by several orders of magnitude, and the associated mitigation shutdown range of 500 meters or more is correspondingly over-protective by several hundred yards. Much has been made of the estimate for as many as 138,000 Level A (potentially injurious) "takes" in the Bureau of Ocean Energy Management's (BOEM) Programmatic Environmental Impact Statement (PEIS) for the Atlantic. Using a more realistic risk criterion based on the above peer-reviewed research, and taking into account standard monitoring and mitigation practices employed by the seismic industry, the more likely estimate of risk is essentially zero; again, consistent with past experience in the Gulf of Mexico and other locations globally.

Time does not allow for thorough scientific rebuttal of all the imaginative "what-ifs" that have been raised by political groups opposed to seismic surveys in the Atlantic. However, I will try to address some of the most commonly used arguments.

In recent years there has been a tendency to ascribe any whale or dolphin stranding in the general area of a seismic survey as having been caused by the seismic sound. There are no diagnostic forensic symptoms of sound-related strandings, so lack of forensic evidence cannot be used to eliminate these arguments based solely on coincidence (past coincidence-based theories for otherwise unexplained strandings include sunspots, geomagnetic anomaliesand earthquakes). When we have had good data on the coincidence of strandings with manmade sound, strandings caused by military sonars, the conditions are very different than what would be encountered during seismic surveys: the sonar sound source is very different from seismic sound (prolonged mid-frequency sonar pings and not short, low frequency seismic impulses); the two different sound sources are operated in very different ways (sonars are typically operated with erratic movements, often at high speeds, compared to the long, slow, straight lines of seismic survey), the animals that strand in response to sonar rarely strand under any other circumstances (beaked whales but not sperm whales, pilot whales or other species that strand frequently for other reasons); the sonar-related strandings occur where deep water is very close to shore, and, finally, the strandings occur within minutes or a couple of hours of the close passage of the sonar (typically less than 20 miles), with the stranded animals spread out by ones and twos over miles of coastline, not bunched-up like most mass strandings. Most important when there is no forensic marker to implicate sound is the statistical recurrence of strandings in places where military sonar training regularly takes place. There is no similar recurrent pattern of stranding in any area where seismic surveys have been regularly conducted over decades. Recently, in Australia and New Zealand, attempts have been made to attribute mass strandings of sperm whales and pilot whales to seismic sound, at sites these species have stranded historically for centuries, even though the seismic surveys were more than 300 miles away! Attempts to link seismic sound to those strandings and to others in Peru, also ignored the much more plausible coincidence of unusually warm water temperatures associated with El Niño/Southern Oscillation (ENSO) in the Pacific Ocean, even though abnormal behavior and mortality of fish, birds, and other species were all indicative of an environmental cause of the strandings, not seismic sound. To date, despite all the clamor on the internet, none of the strandings attributed to seismic

sound fit the criteria seen in strandings related to mid-frequency military sonars, the one and only manmade sound source currently known to cause strandings.

A laboratory study of deformation of scallop larvae by prolonged sound exposure has been frequently cited as evidence that seismic sound can be bad for scallops and other shellfish fisheries. However, a close look at the study reveals many problems. Among the problems are the radical modification of the sound to meet the limitations of the laboratory sound source, and the use of continuous sound exposure for up to 90 continuous hours (5 days) based on the argument that seismic sound at a distance "fills in" the silent spaces between pulses (a circumstance that rarely, if ever, actually occurs). Most important is that the sound source was not miles away as it would be for a 140-160 dB exposure with real seismic sources; rather, the source was within 3-4 inches of the scallop larvae so that the particle motion component of the sound (the biologically relevant component for animals without ears) was equivalent to 195-200 decibels, and not the 140-160 decibels claimed in the paper. Additionally, in laboratory studies of this kind the standard measured effect is mortality, and the fact that this study did not use larval survival data suggests that there was probably no statistical difference in mortality between exposed and control samples of larvae. Instead a subjective measure of "abnormal" development was used, without clearly defined metrics for what constituted abnormal. Control samples are claimed to have produced 100% normal development, with not a single individual out of many thousands showing any abnormalities. A result of 100% in any biological study is always a warning sign that something may not be right. Even in the most normal, healthy sample of individuals, under the best of care, a few defective genetic combinations are to be expected. Yet in this study not a single defect was reported for the control group. This is clearly a study that bears repetition by an independent party. Furthermore, there is evidence of a much more convincing sort, from a study in which real, actual seismic surveys were conducted over the top of an active commercial scallop bed in Tasmania, with fishing before and immediately after the seismic survey. There was no effect from seismic sound on either the amount or the quality of the scallops harvested and larval recruitment was well within normal annual variation.

Claims that seismic sound can or may have effects across hundreds or even thousands of miles are also based on hypothetical conditions that do not stand up under scrutiny. The low frequency component of seismic sound, indeed all natural and manmade low frequency sound, can and often does propagate hundreds or thousands of miles within an oceanographic feature called the Deep Sound Channel or Sound Fixing and Ranging (SOFAR) channel. While this channel may be at relatively shallow depths near the poles, over most of the world's oceans the SOFAR channel is 800-1000 meters deep, about half a mile. In fact, the SOFAR channel figures prominently in the early history of this environmental issue, when some of the same people now claiming that seismic sound is louder than 100,000 jets and will deafen all the whales of the world, also claimed that an 11 Watt sound source (equivalent to a home stereo) was louder than 10,000 jets and would deafen all the whales of the world. The 11 Watt source was part of an experiment to measure the temperature of the deep ocean for climate change studies, the Acoustic Thermometry of Ocean Climate (ATOC) study of 1995-1999. While the study clearly did not deafen all the whales in the ocean, it did give birth to a thriving community of organizations opposing any and all manmade sound in the sea. Many of the watchwords and slogans still in use today, such as "a deaf whale is a dead whale" and comparisons to nuclear bombs, explosives and jet engines were invented during opposition to the ATOC study and still seem to attract donations and media attention today as well as they did 20 years ago when the sound source of concern was the equivalent of a home stereo.

The other problem for the hypothesis that sound in the SOFAR channel will disturb large baleen whales is that large baleen whales don't dive that deep. In the predecessor to the ATOC study, the Heard Island Experiment, distant sperm whales appeared to respond with brief temporary silencing

(listening) to the sound source. But sperm whales are deep divers and regularly enter the SOFAR channel: whales that use low frequency sound and are assumed to hear well at those frequencies, like blue whales, fin whales, right whales and other large baleen whales, rarely dive more than 100 meters deep, if that far. Even when the whales are just a few hundred meters above the SOFAR channel, less than half a mile, the amount of sound "leaked" from the SOFAR channel is below ambient noise levels, and is thus inaudible to the whales. In other words, it does not matter that the sound in the SOFAR channel is audible to whales if they don't go into the SOFAR channel.

One should also ask what a whale would make of acoustic "information" that has travelled thousands of miles. Information about food, predators or prospective mates loses some of its immediacy if it would take 2-4 weeks to swim to the location of the sound source and, yes, whales can tell distant sound sources from nearby sound sources just as well as we can.

Related to the idea of whales being affected by sounds hundreds or thousands of miles away are the claims that manmade sound might mask, or interfere with, social sounds like mother-calf calls and mating calls. Concepts like Acoustic Space, Soundscape, Acoustic Footprint, or Auditory Scene are not new and were first developed to characterize the challenges we humans have in understanding speech in a noisy environment. Not surprisingly, the most effective masking sound is the sound made by other members of your species, since the sound is at the same frequency and loudness of your own sounds of interest. Therefore all animals, including humans, have developed some pretty amazing abilities to remove potential masking noise from the sounds of interest to us; the Cocktail Party Effect perfectly describes the acoustic scene in which our hearing is most challenged and yet we still manage to hear the speaker of interest to us.

Confusion arises from misuse of the The Equal Energy Rule of masking, which states that an equal amount of noise energy within the frequency band of interest has the potential (and I emphasize the word 'potential") to mask a sound of interest in that same frequency band. It is a rule that works better for listening machines than for animals. All animals, including humans and whales, can and do muster a wide variety of sound processing abilities to hear sounds of interest within an auditory scene containing much louder sounds that are not of interest (noise). A typical listener gets anywhere from 10-30 dB of "signal gain" through spatial release from masking, temporal release from masking, out of band listening, auditory system gain, and other well-studied phenomena, along with more exotic forms of masking release like co-modulation release from masking. That is, a sound of interest can be heard in noise that is 10-30 dB louder than the signal. While some of these de-masking phenomena are acknowledged on paper by those claiming that manmade noise masks whale sounds, the de-masking abilities are for some reason never incorporated into the calculations of "acoustic footprints" for shipping, sonars, seismic and other sound sources. Actually, seismic sound is a very ineffective masker because of its short duration and intermittency. The seismic pulse is only 0.1 second long, followed by 10 seconds of silence. Even in highly reverberant or "echoic" environments, the echoes between pulses do not fill the entire sound space evenly and are typically 10-60 dB quieter than the pulses themselves. Given the redundancy of animal calling behavior and the rich harmonic content of most biological signals it is highly unlikely that seismic sound would ever, under any circumstances, provide significant masking of sounds important to the animals.

Playing on people's emotions by invoking mother-calf separation due to masking of contact calls is an especially implausible overreach for masking. The close spatial bond of mother and dependent calf, where separation is rarely if ever more than a few hundred yards, is simply not going to be affected at all by seismic sound at any range, let alone hundreds or thousands of miles.

In the end, Bill Brown, Chief Environmental Officer of the US Bureau of Ocean Energy Management says it best:

"*…there has been no documented scientific evidence of noise…from seismic activities adversely affecting marine animal populations or coastal communities. This technology has been used for more than 30 years around the world…with no known detrimental impact to marine animal populations or to commercial fishing*."

Confidence in our lack of environmental impact should not be taken to imply that we have ceased to look for potential risk factors or to explore alternative means of doing our job that seem to offer even greater assurance of no effect. Together with the Sound and Marine Life Joint Industry Program, we continue to invest in independent research, with over $18 million invested in the last three years alone; exploring the potential of alternative sound sources, improving the effectiveness of acoustic monitoring of marine life, assessing behavioral responses of whales to seismic surveys, and more. A link to the website where this research is featured has also been provided in the supporting materials submitted with this testimony.