energy API

International Association IAGC of Geophysical Contractors

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Attn: Amy R. Scholik-Schlomer, Office of Protected Resources

Re: User Manual and associated optional User Spreadsheet Tool for the NOAA 2018 Revised Technical Guidance

To Whom It May Concern:

This letter provides the comments of the American Petroleum Institute and the International Association of Geophysical Contractors (collectively, the "Associations") in response to the National Marine Fisheries Service's ("NMFS") notice and request for comments to assist the Secretary of Commerce's review of the User Manual and associated optional User Spreadsheet Tool for the NOAA 2018 Revised Technical Guidance Technical Guidance. These comments follow our previously submitted comments on the first and second draft versions of the Technical Guidance, as well as our comments on NMFS's 2016 proposed revisions to the draft Technical Guidance (see letter July 17, 2017, attached). The comments provided below are specifically intended to inform the Secretary of Commerce's review of the User Manual and associated optional User Spreadsheet tool.[1]

I. INTRODUCTION

Executive Order (EO) 13795, expressly states that it "shall be the policy of the United

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[1] We incorporate our previous three comment letters (including attachments) by reference, and expect that those comments will be considered as part of the review ordered by EO 13795. Collectively, the Associations represent the vast majority of all stakeholders engaged in the exploration and development of offshore oil and gas resources in the United States. The Associations are described in more detail in our previous three comment letters.

States to encourage energy exploration and production, including on the Outer Continental Shelf ["OCS"], in order to maintain the Nation's position as a global energy leader and foster energy security and resilience for the benefit of the American people, while ensuring that any such activity is safe and environmentally responsible."[2] This directive is consistent with statutorily enacted policy calling for the "expeditious and orderly development" of the U.S. OCS "subject to environmental safeguards." 43 U.S.C. § 1332(3). Indeed, Congress enacted the OCS Lands Act to "achieve national economic and energy policy goals, assure national security, reduce dependence on foreign sources, and maintain a favorable balance of payments in world trade." 43 U.S.C. § 1802(1).

Seismic surveying is essential to achieving the goals stated by the EO and OCSLA because it is the only feasible technology available to accurately image the subsurface of the OCS before a single well is drilled. Technological innovations and improvements afford industry significant precision in subsurface imaging and will continue to provide more realistic estimates of potential resources. Furthermore, modern geophysical imaging reduces risk by increasing the likelihood that exploratory wells will successfully tap hydrocarbons and by decreasing the number of wells that need to be drilled in a given area, thereby reducing associated safety and environmental risks and the overall environmental footprint for exploration. Because geophysical activities are temporary and transitory, seismic surveying is the least intrusive and most cost-effective means to determine the likely locations of recoverable oil and gas resources on the OCS.

The Technical Guidance and associated User Guidance and User Spreadsheet Tool are directly relevant to essential offshore geophysical activities because federal agencies and permit applicants will use the guidance to determine the potential effects of offshore geophysical activities on marine mammals. Although NMFS must ensure that all statutory requirements are satisfied when issuing incidental take authorizations ("ITAs") under the Marine Mammal Protection Act ("MMPA"), it also must ensure that the MMPA permitting process does not undermine the goals stated in OCSLA and the EO. Moreover, BOEM, which may use the Technical Guidance in its National Environmental Policy Act analyses, is required to implement OCSLA's (and the EO's) mandates.

As requested by NMFS, our comments focus on (1) the technical merits of the September 24, 2018 updated User Guidance and associated User Spreadsheet tool and (2) recommendations for how NMFS can improve the application and implementation of the Technical Guidance and associated User Spreadsheet tool.

II. COMMENTS

We commend NMFS for its commitment to refining the 2018 Technical Guidance and associated User Guidance and Spreadsheet Tool, and we are eager to work with NMFS to develop the NMFS-requested improvements and updates to the User Guidance and Spreadsheet

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[2] Presidential Executive Order Implementing an America-First Offshore Energy Strategy (April 28, 2017), https://www.whitehouse.gov/the-press-office/2017/04/28/presidential-executive-order-implementing-america-first-offshore-energy.

tool. In this comment letter we have focused specifically on the guidance relevant to intermittent impulse sound sources of the type used in geophysical surveys for research and industrial applications (Tab F, Impulsive, Mobile).[3]

While these user tools are much improved over previous Alternative Methodology spreadsheets and guidance (2015 and 2016 Technical Guidance drafts), the current User Guide and associated optional User Spreadsheet tool still fall short of rendering the NMFS 2018 Acoustic Guidance useful, practicable and effective. In particular, the default Weighting Factor Adjustments ("WFA") are, as NMFS acknowledges, "more conservative" than applying the full weighting function calculations. Second, whether one uses the WFA or the one-third octave weighting tool as illustrated in Table 3, p. 11-12 of the User Guidance, there are still a number of user-entered values that only a sophisticated user would be prepared to derive or properly apply (e.g. derivation of SPL_{peak} from the impulse time series, derivation of SPL_{rms} and SEL from the root-mean-squared average of pressures over the time/amplitude pressure signature, and, finally, derivation of a frequency spectrum from the impulse waveform by applying a deconvolution algorithm like a Fast Fourier Transform). The above-listed features of the sound source, as well as their derivation and significance, are not addressed by the User Guidance, nor are there suitable references provided to assist anyone less than a highly trained expert in translating an impulse sound waveform or similar information about their sound source into the values required by the Spreadsheet Tool.

A. Weighting Factor Adjustment (WFA)

Put most simply, the alternative WFA calculation removes the challenge of applying weighting functions to a frequency-deconvolved impulse by doing away with the weighting functions. The magnitude of the difference in outcomes between applying the WFA and a simple one-third octave weighting adjustment is best illustrated by NMFS' own User Guidance (Manual for the Optional Spreadsheet Tool, Table 4 on page 13). The weighted source levels for the selected seismic array are anywhere from -12 dB for the Low Frequency ("LF") Cetacean Hearing Group to -28 dB for most of the other hearing groups relative to the unweighted values, meaning that the WFA method overpredicts the actual threshold for temporary threshold shifts ("TTS") and permanent threshold shifts ("PTS") by 12 to 28 dB.

When translated into a regulatory outcome like ensonified area and estimated takes, the absence of biologically-relevant weighting in the WFA methodology is even more obviously impactful. Applying the spherical spreading algorithm that NMFS uses to estimate the range to threshold (20log(radius)), the WFA produces a range to threshold that in most cases is more than double the range-to-threshold generated by the weighted SEL value. Since the area ensonified is a square function of range (the area of a circle or pi times range-squared), a doubling of range to threshold means a quadrupling of the area ensonified. Assuming equal distribution of animals

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[3] FR 83 (185): 48292, September 24, 2018 "NMFS invites comment on how we can further refine the User Manual to aid in the application and implementation of the 2018 Revised Technical Guidance. Input from stakeholders provided during this public comment period will inform updated versions of the User Manual and/or associated optional User Spreadsheet tool, which may be issued as early as the end of 2018."

throughout the area, this also translates to a four-fold increase in estimated takes when a user applies the WFA methodology instead of applying the weighted SEL offered by NMFS (2018). Overpredicting the most likely best-available-science ("BAS") estimate of take from NMFS (2018) by 400% does not seem to fall within the realm of "reasonable" conservatism. It is hard to imagine any permit applicant willingly subjecting themselves to such a severe penalty for the convenience of using the WFA methodology.

B. Entries Required from the User in Order to Apply the Spreadsheet Tool

Despite the great progress NMFS has made in making the Manual and Spreadsheet more user-friendly, there are parts of the process that still call for a level of expertise that most users should not be assumed to possess.

The Manual and Spreadsheet asks for a Source Level expressed as RMS SPL and Peak (pk) SPL. Most industry models and measurements deliver a peak pressure value in bars[4], but that can be relatively easily converted to dB SPL re 1 microPascal peak (SPL_{pk}) (i.e.: 1 bar = 10^{11} microPascal = 220 dB SPL re 1 microPascal[5]).

However, a common source of error comes from using the nominal source level of the array in the vertical direction instead of the actual produced sound pressure levels. Use of the nominal array point source value overestimates the actual achieved source level in SPL_{pk} by 20 dB or more, depending on the number of array elements and the angle of the receiving animal relative to the array. Sophisticated models like the JASCO model in the BOEM (2017) EIS as cited by the User Guidance will take the complex sound field of the array into account when calculating received level at a given receiver position, but entering the nominal vertical array source level into the User Spreadsheet results in an over-estimation of the greatest actual measurable sound pressure anywhere in or around the array by 10-20 dB or more, because even in the straight vertical direction the sound pressure wave from the separate elements in the array do not become coherent until the sound is 10-30m from the source depending on frequency and array geometry.

For example, a JASCO modeling and measurement study of a 2,380 cubic inch, 22 element array (McPherson et al, 2018) produced a nominal modeled source level in the vertical direction of 254.6 dB SPL_{pk} (p. 8), yet a direct pass over a recorder 75 meters from the receiver only produced a received SPL_{pk} of 220.6 dB (McPherson et al 2018, p. 13). In other words, for a nominal source level of 254 dB SPL_{pk}, an animal 80 meters directly below the source might experience a received level 34 dB below than the nominal source level, while animals at various angles out to the horizontal might experience a further 5-10 dB reduction in received level due to decreases in array gain at angles away from the vertical (McPherson et al, 2018; Goertz et al, 2013). Fortunately, various researchers and industry studies can now provide a wealth of data on the actual sound fields produced by arrays of various nominal source levels, and a conversion

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[4] The non-expert reader may recognize bar as a measurement of pressure from weather forecasting, where millibars (mb) are used to measure atmospheric pressure.

[5] SPL_{pk} re 1 μPa = 20 $\log_{10}$ [pressure in microPascals]

factor could easily be generated for converting nominal SPL_{pk} into actual SPL_{pk} in physical space, rather than allowing errors in take estimates to arise from the misapplication of nominal source levels in the User Spreadsheet tool.

SPL_{rms} and SEL are derived from a knowledge of SPL_{pk} and pulse duration, but here again, the non-expert user is unlikely to be able to derive SPL rms and thus SEL from a measured or modeled time/amplitude sound pressure signature without some expertise. Fortunately, there is likely now enough data on the relationship between SPL_{pk}, SPL_{rms} and SEL to apply generic correction factors for deriving SPL_{rms} and SEL from SPL_{pk} data or model results. For example, the McPherson et al (2018) study revealed a very consistent relationship between SEL and SPL_{pk}, with SEL about 20 dB below SPL_{pk}. Thus, a signal at 100 m slant range at 210 dB SPL_{pk} produced an unweighted SEL level of 190 dB. Other studies cited in this comment letter reveal a similar relationship between SPL_{pk}, SPL_{rms} and SEL for seismic arrays generally.

NMFS provides some common tools for converting dB SPL_{rms} to SEL on page 18 (Equation 1) of the Manual and again on page 91-92 (Appendix C), but converting dB SPL_{pk} into dB SPL_{rms} can be computationally difficult and is usually done instead by a rough approximation of the peak SPL relative to the total duration of the pulse, in much the same way that SEL is derived from SPL_{rms} over time in Equation 1. A more practicable solution would be to simply impose a generic scaling function derived from multiple examples from real array data.

Perhaps the most technically challenging task for the user of the NMFS guidance is the calculation of the frequency spectrum of an impulse sound. This usually involves starting with a digital expression of the pulse waveform (a time/amplitude waveform as in the following graphic image) and performing a mathematical deconvolution of the pulse into component frequencies. The Fast Fourier Transform ("FFT") is the most common mathematical tool transforming a time/amplitude pulse like the one below into a frequency spectrum of the type illustrated in Wisloff et al (2014) below. The FFT formula is a common engineering and physics tool; MatLab and even Excel offer FFT calculators, though the Excel version does not have sufficient frequency bandwidth to be useful for a seismic sound source. However, these tools must be fed a comma-separated values (.csv) file of thousands of data points from the impulse pressure time series. Completing the required steps to generate a frequency spectrum for applying weighting factors is also beyond what a non-expert or even moderately expert user can be expected to do on their own. This renders the Spreadsheet tool useless even for the WFA methodology, and even with the assistance of the User Guidance.

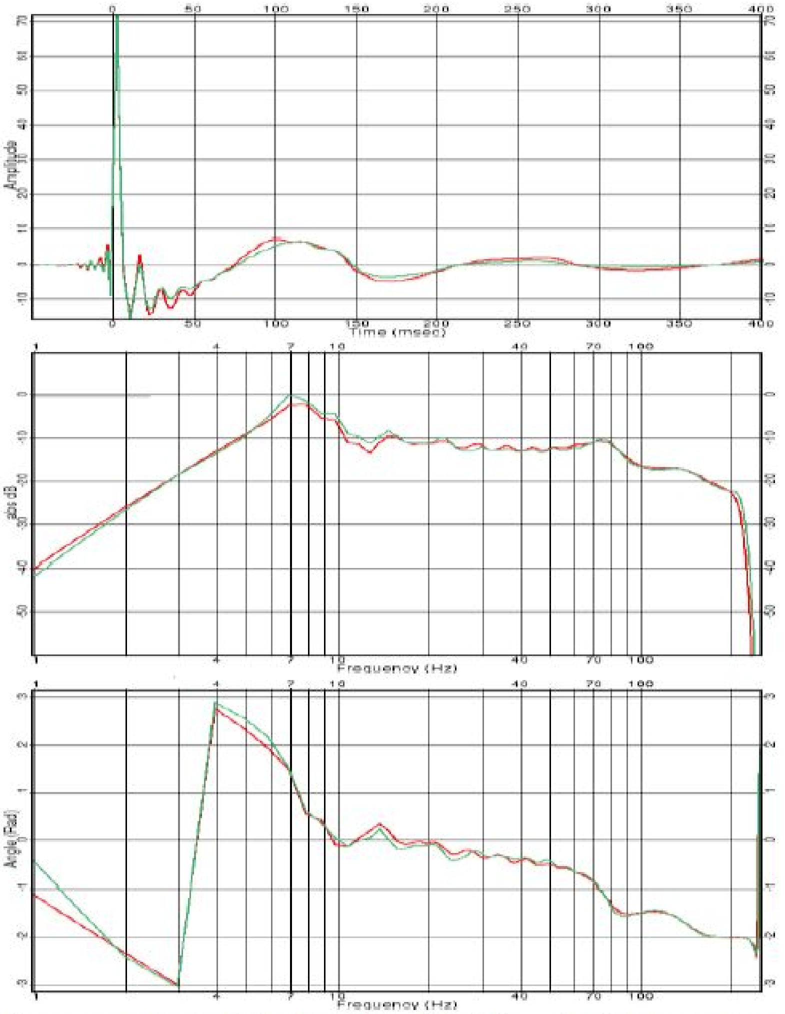
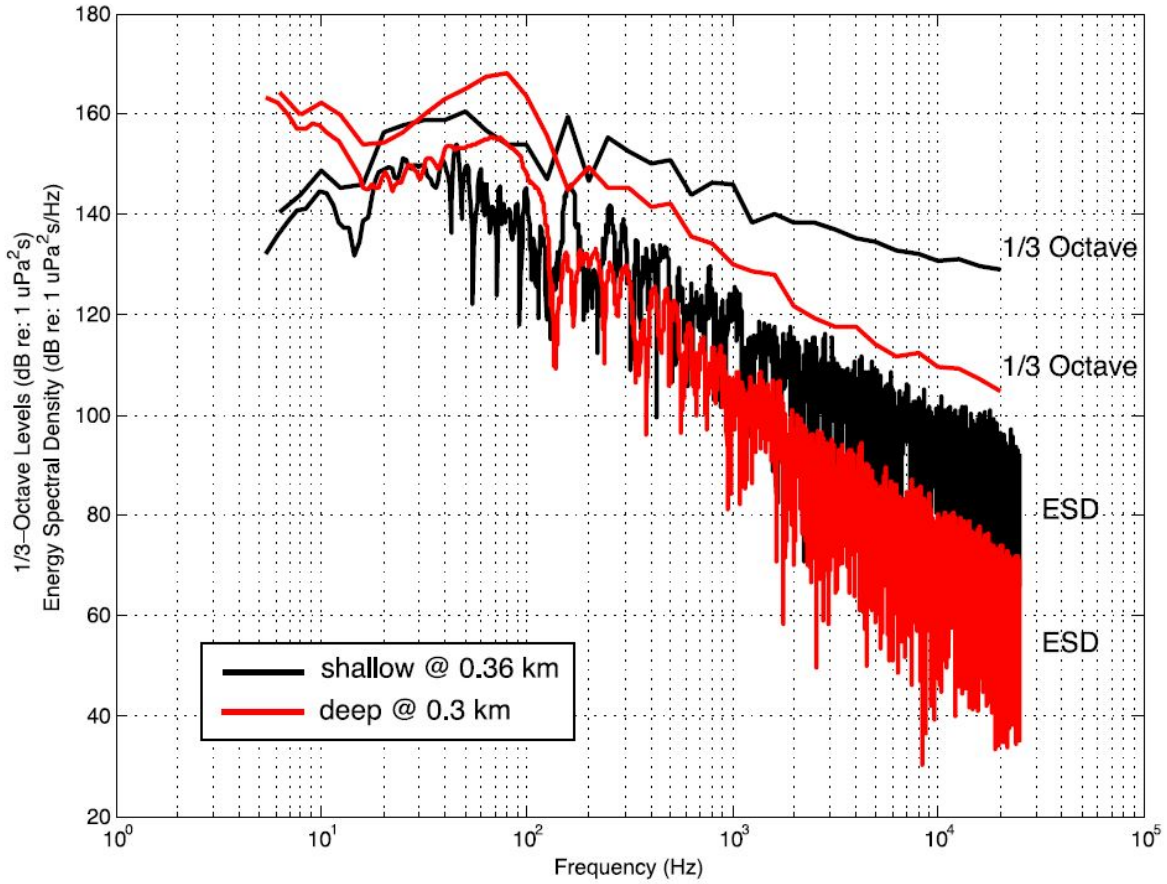


Figure 5: Measured (red) and modeled (green) signatures for a 4135 cu.in G.GUN II array compared in time, frequency and phase, data courtesy of Total.

NMFS apparently did not have digital files of seismic pulses for use in their User Guidance and resorted to a software application that prepares a digital file by hand tracing a graphic image (https://automeris.io/WebPlotDigitizer/). Having tried the WebPlotDigitizer app, we feel confident in asserting that this approach is still not likely to be a practicable way to allow the non-expert user to apply the NMFS guidance. Tracing images to create digital files also offers considerably more room for user-generated errors in data entry and inserts an unreplicable step (the tracing of an image) into the analysis process. A more workable solution may be to examine the frequency spectra from multiple seismic arrays, determine whether the frequency spectra differ appreciably in their frequency structure, and from these data derive a generic frequency spectrum that captures the general features of seismic sound sources as a category. As is the case for the relationship between SPL_{pk} and SEL, frequency spectra from seismic sources differ very little, especially at the ranges relevant to this guidance (generally less than 1 km).

The Associations commend NMFS for facilitating the use of a simplified 1/3 octave band analysis process for applying weighting to the frequency spectrum of the pulse. The value of using octave band or 1/3 octave band averaging is that it reduces the number of calculations to about 12 to 36, which is an easy spreadsheet exercise, whereas a full spectrum-level calculation of the weighted SEL for a broadband seismic signal could involve 5000 or more calculations (assuming a relevant frequency bandwidth of about 5000 Hz). Here again the seismic industry could help NMFS produce a generic tool for calculating an appropriately weighted seismic sound, having already developed such a tool for internal use by IAGC members.

While there are nuances to array design for geophysical imaging purposes, these nuances do not particularly impact the biologically-relevant frequency structure of the pulse. The example provided by NMFS in the User Guidance (page 13, Figure 7) is from a hypothetical array, not an array actually used for geophysical surveys, but it is typical of most arrays in having relatively flat energy levels in the range of 10-100 Hz, then falling off at higher frequencies. Nuances in energy output below 7 Hz fall below the hearing range of even LF Cetaceans and are therefore not germane to the calculations of hearing risk from seismic sources. Most arrays also show a frequency-specific drop-off of 40-60 dB between 100 Hz and 1 – 5 kHz, with relatively flat energy levels beyond 5 kHz, some 40-60 dB SEL (spectrum level) below the SEL level at peak frequency. The drop-off appears less dramatic in Figure 7 of the NMFS User Guidance because the width of the bands increases logarithmically with frequency, meaning that more energy is subsumed under a 1/3 octave band centered at 1000 Hz summing the energy across 231 Hz (891-1122 Hz) than a 1/3 octave band at 20 Hz summing the energy across only 4 Hz (18 – 22 Hz). A similar comparison of single frequency and 1/3 octave band representations of SEL (Tolstoy et al, 2009, below) illustrates this phenomenon of increasing bandwidth leading to the appearance of greater SEL values at higher frequencies when energy is summed in log scale bands versus single frequency values. One-third octave bands are commonly used for assessing biological responses to sound because the ear is also a log scale frequency integrator. Again, this is a nuance of applying frequency weighting that might escape many non-expert users of the NMFS (2018) Acoustic Guidance and the associated User Guidance and Spreadsheet tool.



C. Toward a Generic Seismic Source Parameterization

As noted above, initial examination of the literature on seismic source properties suggests that it should be possible to generate a generic correction factor for converting from nominal SPL_{pk} source level to an actual SPL_{pk} source level in much the same way that NMFS has already arrived at 100 msec for the typical pulse duration at the source or 20 log(r) for sound attenuation over distance (also see the previous discussion of McPherson et al, 2018 in this comment letter). Thus, the most common output from a source model like Gundalf, NUCLEUS, or JASCO's AASM, i.e. a nominal source level in the vertical direction, could be confidently converted to an actual SPL_{pk} for application in the User Spreadsheet Tool.

Derivation of the other user-entered values such as SPL_{rms} and even SEL are also possible. For example, the SPL_{rms} value is typically 10 dB lower than the dB SPL_{pk} for a seismic pulse, and then SEL is another 10 dB lower than that. This is a robust relationship that shows up in several publications in which SPL and SEL data are presented for seismic sources (e.g. Diebold et al, 2010; Breitzke et al 2008).

Assessments have already been made of the consistency of seismic array parameters (Crone et al, 2017; Breitzke et al, 2008 are just a limited number of published or unpublished technical data on array acoustics). Additional published and unpublished data can be assembled with additional searching of the literature and the archives of IAGC and API members. A joint

NMFS/industry examination of published and unpublished data sets is therefore likely to yield a set of generic parameters for the relationship of SPL_{pk} to SPL_{rms} and SEL, and for the typical frequency spectrum of a seismic array. These values could then be calibrated to the most commonly used metric for seismic array characterization, the nominal source level (in bar-m, Pascals or SPL re 1 microPascal), and then applied to the NMFS User Spreadsheet. We suggest a preliminary discussion of this potential solution to the current difficulties with the NMFS PTS/TTS criteria at NMFS convenience, with a potential target date being the NMFS proposed December 2018 revision schedule. IAGC and API would be willing to bring the expertise of the technical staff within their member companies to bear on the subject, along with that of experts from the academic geophysics community and BOEM, as desired.

III. SUMMARY

The NMFS Manual for the Optional Spreadsheet Tool and the Acoustic Guidance 2018 User Spreadsheet are not at present “useful, practicable and effective”, a shortcoming shared by the 2018 NOAA Guidance itself. Assuming a user was able to successfully navigate the hurdles of sorting out the SPL_{pk}, SPL RMS, and duration/SEL entries, and was then able to generate a frequency spectrum of the impulse sound source, the user is still faced with a choice of using the easier WFA option offered by NMFS and thereby being seriously penalized with an approximate four-fold overestimation of take (or higher), or choosing to perform a fairly challenging substitution of frequency-weighted values across thousands of Hz to calculate a weighted SEL for their sound source according to NMFS 2018 guidance. Applying generic metrics for these properties of a seismic source is the only practicable path toward making the NMFS 2018 Guidance useful, practicable and effective, as mandated by the Marine Mammal Protection Act.

Having examined the available data from a variety of seismic survey sources, the industry believes that a collaboration with NMFS will yield the desired generic parameterization of the User Spreadsheet and User Guidance that is NMFS’ goal. We look forward to working with NMFS to establish generic parameters for seismic survey sources.

Sincerely,

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