13 January 2023

Ms. Jolie Harrison, Chief
Permits and Conservation Division
Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway
Silver Spring, MD 20910-3225

Dear Ms. Harrison:

The Marine Mammal Commission (the Commission), in consultation with its Committee of Scientific Advisors on Marine Mammals, has reviewed the National Marine Fisheries Service's (NMFS) 23 December 2022 notice (87 Fed. Reg. 79072) and the letter of authorization (LOA) application submitted by Revolution Wind, LLC (Revolution Wind) seeking promulgation of regulations under section 101(a)(5)(A) of the Marine Mammal Protection Act (the MMPA). Taking of marine mammals would be incidental to construction of the Revolution Wind offshore wind energy facility and other associated activities. Revolution Wind's windfarm area is located 24 km southeast of Rhode Island[1].

**Background**

Revolution Wind is proposing to conduct (1) impact pile driving to install up to 79 tapered 7/12-m monopiles to support wind turbine generators (WTGs) and two tapered 7/15-m monopiles to support two offshore substations (OSSs), (2) vibratory pile driving and removal of up to two temporary cofferdams *or* impact pile driving and removal[2] of two temporary casing pipes and vibratory pile driving and removal of 12 goal posts[3] to assist in the installation of the export cable route, (3) detonation of up to 13 unexploded ordnances or munitions and explosives of concern (UXOs), as needed, and (4) high-resolution geophysical (HRG) site characterization surveys of the inter-array cable and export cable construction areas. Revolution Wind would install the monopiles using an impact hammer on up to 29 days in water depths of 24 to 50 m. Vibratory pile driving and removal could occur on up to 28 days and impact pile driving and removal of casings could occur on up to 8 days in water depths of up to 45 m. UXO detonations would occur for no more than 13 days in water depths of up to 40 m. In addition, Revolution Wind could use non-parametric sub-bottom profilers (including chirps, sparkers, and boomers), parametric sub-bottom profilers, multibeam echosounders, side-scan sonar, and acoustic positioning systems for up to 137 days during its HRG surveys in water depths of up to 50 m. Mitigation measures would include time-area restrictions, sound attenuation system usage and minimum operating requirements, visual and

[1] In the Bureau of Ocean Energy Management (BOEM) lease area OCS-A 0486, within the Rhode-Island Massachusetts Wind Energy Area.
[2] Termed pneumatic hammering in the *Federal Register* notice.
[3] Each goal post would be composed of two vertical sheet piles and a horizontal cross beam with six goal posts supporting each casing pipe.

passive acoustic monitoring to implement clearance, delay and shut-down procedures, sound field verification (SFV) with mitigation and monitoring zone adjustments and additions to sound attenuation systems as needed, soft-start and ramp-up procedures, and various vessel strike avoidance measures.

**Impact pile driving**

The Commission reviewed Revolution Wind's application, JASCO Applied Sciences Inc.'s (JASCO) underwater acoustic and exposure modeling reports[4], and NMFS's preamble to and the proposed rule. The Commission's review revealed numerous issues, and many of the same or similar issues were discussed in the Commission's 6 December 2022 letter regarding the request by Ocean Wind, LLC (Ocean Wind) to install monopiles off New Jersey and the 1 March 2021 letter regarding South Fork Wind, LLC's request to install monopiles off Rhode Island.

*Level A and B harassment zones for impact pile driving of 7/12-m and 7/15-m monopiles*—JASCO used its pile driving source model (PDSM) and various sound propagation models (see JASCO's underwater acoustic and exposure modeling report in Revolution Wind's application) to estimate the ranges to effect for the monopiles. Rather than re-iterate the detailed rationale and justification specified in previous letters, the Commission's most recent 6 December 2022 letter should be reviewed in concert with this letter. Briefly—

- PDSM, which is a time-domain finite-difference (TDFD) model, has not been validated by in-situ measurements, but the model has underperformed when compared to finite element (FE) models as part of a benchmark validation (Lippert et al. 2016). Specifically, Lippert et al. (2016) indicated that the sound exposure levels (SELs) predicted by JASCO's TDFD PDSM were approximately 2.5 dB lower than the various FE models at 750 m.
- Although the FE models simulate energy loss due to friction in an indirect manner, estimation of such loss following Zampolli et al. (2013) has been validated based on in-situ measurements and is more reflective of real-world scenarios than assuming a reflection coefficient just at the pile foot, as is the case for TDFD PDSM.
- To substantiate the Level B harassment zones estimated by JASCO, NMFS could have used the damped cylindrical spreading model (DCSM; Lippert et al. 2018) *and* the source levels provided by TDFD PDSM. Level B harassment zones also could have been scaled based on differences in source levels and known initial zones.
    - If one were to use DCSM and assume a 3-dB difference in source levels, the model-estimated Level B harassment zone of approximately 3,833 m, and $\alpha$=0.963 dB/km (based on medium sand and the mean modeled scenario of 39.1 m of water depth[5]), the model-estimated zone would increase by 41 percent[6] resulting in a zone of approximately 5,405 m for the 7/12-m monopiles.

[4] Appendix A in Revolution Wind's application is JASCO's underwater acoustic and exposure modeling report, and Appendix B is JASCO's underwater acoustic modeling of UXO detonations report.
[5] JASCO used water depths of 36.8 and 41.3 m for its modeling of 7/12-m monopiles (Table 3 in JASCO's underwater acoustic and exposure modeling report).
[6] A 34-percent increase is estimated when assuming a 2.5-dB difference in source levels.

  - If, on the other hand, one were to assume a 3-dB difference in source levels and a worst-case scenario of 50 m of water depth[7], the model-estimated Level B harassment zone would increase by more than 46 percent[8] resulting in a zone of more than 5,610 m for the 7/12-m monopiles.

- When comparing JASCO's model-estimated single-strike SELs ($SEL_{ss}$) at 750 m to those from the Institute of Technical and Applied Physics (itap) GmbH's[9] empirical model, JASCO's $SEL_{ss}$ are greater than itap's values for the 7/12-m monopiles (up to 3 dB more across hammer energies[10]) and less than itap for the 7/15-m monopiles (up to 3 dB less across hammer energies of 2,000 to 4,000 kJ; see Tables I-1 and I-2 in Appendix I of JASCO's underwater acoustic and exposure modeling report).
  - This directly refutes JASCO's claim in the Tables' accompanying text that, at lower hammer energies, the model-estimated $SEL_{ss}$ were less than those from itap and greater than those from itap at higher hammer energies. The differences were based on the pile size (and maybe penetration depth, although that was not specified), not hammer energies.
  - Conversely, the $SEL_{ss}$ trend data for Ocean Wind were 4 to 6 dB less than those from itap for hammer energies of 3,000 kJ or less. The inconsistent variability has implications regarding the accuracy of the model and the potential underestimation of Level A harassment zones, particularly since 92 percent of the total estimated number of strikes would originate at energies of 2,000 to 4,000 kJ for the 7/15-m monopiles (Table 12 in the *Federal Register* notice).
- In-situ measurements[11] for impact driving of a *7.8-m pile* with a measured 9–12 dB sound attenuation reduction during use of a double big bubble curtain for a hammer operating at a maximum of *550 kJ* estimated the Level B harassment zone to be 3,891 m[12] (WaterProof 2020); whereas, JASCO estimated the Level B harassment zone for impact driving of *7/12-m piles* to be 3,833 m[13], assuming a 10-dB sound attenuation reduction factor based on use of two sound attenuation devices and up to *4,000 kJ* of hammer energy (see Table 17 in Revolution Wind's application).
  - It is unrealistic that an impact hammer with seven times more energy intensity would result in a smaller harassment zone[14].
  - Similar results of more than a 7-dB difference between source levels at 500 and 4,000 kJ hammer energies are evident in the itap data as well (Bellmann et al. 2020; see

[7] $\alpha$=0.753 dB/km.
[8] A 34-percent increase is estimated when assuming a 2.5-dB difference in source levels.
[9] See Appendix I in JASCO's underwater acoustic and exposure modeling report.
[10] And 1 dB less for a few instances at hammer energies of 3,000 and 4,000 kJ.
[11] In water depths of approximately 25 m with medium sand substrate and an $\alpha$=1.47 dB/km.
[12] Dominion Energy Virginia's (Dominion) model-estimated Level B harassment zone that assumed a 10-dB sound attenuation reduction also was smaller than the zone measured in the field (85 Fed. Reg. 30940).
[13] The Level B harassment zone for the 7/15-m monopiles was estimated to be 4,100 m—both estimates are for summer.
[14] Since the impact hammer for Revolution Wind could exert 7 times more energy than the hammer used for Dominion, the source level for Revolution Wind would be more than 8 times larger than was determined by Dominion, resulting in a source level increase of 9 dB (4,000 kJ/550 kJ)/(22.0 m/24.5 m)=8, with 10log(8)=9 dB. Based on DCSM, a 9-dB difference in source levels, the measured Level B harassment zone of more than 3,890 m at Dominion, and $\alpha$=1.47 dB/km for Dominion, the measured Level B harassment zone would more than double and result in a Level B harassment zone of approximately 7,900 m.

Table I-1 of Appendix I of JASCO's underwater acoustic and exposure modeling report for Ocean Wind).

As indicated in previous Commission letters, if JASCO's model(s) is inaccurate, it would have repercussions across the wind energy industry and could cause unnecessary delays, require additional costs, and hinder wind energy operators from meeting their milestones and adhering to their tight schedules. Further, given the scarcity of available installation vessels and appropriately-sized hammers in the United States, delays for a single project could ripple through the industry. So as not to hamper wind energy installation progress, the Commission recommends that, until JASCO's model has been validated with in-situ measurements of impact installation of monopiles in the northwest Atlantic, NMFS require Revolution Wind and thus JASCO to re-estimate the various Level A and B harassment zones for the final rule using source levels that are at a minimum 3 dB greater than those currently used.

These modeling issues do not include whether the 10-dB sound reduction assumption[15] used to inform the Level A and B harassment zones, numbers of takes, and mitigation and monitoring measures is either valid or attainable. If Revolution Wind is unable to achieve the presumed 10-dB sound reduction, those shortcomings could have numerous consequences.

*In-situ measurements of 7/12-m and 7/15-m monopiles*—Revolution Wind would be required to conduct in-situ measurements of the first three monopiles[16] to determine whether the in-situ Level A and B harassment zones are greater than the model-estimated zones and, if so, to add additional or modify the current sound attenuation measures and devices, increase the range(s) of the zones, and conduct additional measurements to ensure the model-estimated zones are not exceeded[17] (see section 217.274(d)(3) in the proposed rule). It is unclear how Revolution Wind will meet these requirements if the model-estimated Level A or B harassment zones have been vastly underestimated for monopiles. It also is unclear which model-estimated zones (i.e., acoustic ranges, exposure ranges[18], or mitigation and monitoring zones[19]) and which metric (flat $R_{max}$, flat $R_{95\%}$) the in-situ measurements would be compared to and which zone (i.e., acoustic or exposure ranges[20]) and metric would be calculated from the in-situ measurements. Specifically, exposure ranges are two to three

[15] Based on use of a double bubble curtain or other sound-attenuating devices.
[16] And those thereafter that are not represented by the previous three locations (i.e., substrate composition, water depth).
[17] If use of additional and modification of current sound attenuation measures still do not achieve ranges less than or equal to those modeled, assuming a 10-dB attenuation, and no other actions can further reduce sound levels, the clearance and shut-down zones would be expanded in consultation with NMFS. If harassment zones are expanded beyond an additional 1,500 m, additional PSOs would be deployed on additional platforms, with each observer responsible for maintaining watch in no more than 180° and of an area with a radius no greater than 1,500 m.
[18] Acoustic ranges represent the distance to a harassment threshold based on sound propagation through the environment (i.e., independent of any receiver); while exposure ranges represent the distance at which an animal can accumulate enough acoustic energy to exceed a harassment threshold based on how it moves through the environment (i.e., using animat movement modeling; 87 Fed. Reg. 79115).
[19] Level A harassment zones were based on exposure ranges and, depending on the species, inform the mitigation zones; while Level B harassment zones were based on acoustic ranges and inform the monitoring zones (see Table 34 in the *Federal Register* notice).
[20] Cumulative SELs ($SEL_{cum}$) can be measured in situ and weighted for acoustic ranges; while exposure ranges would need to be calculated based on an in-situ measured source level, environmental and animat modeling parameters, and the number of pile strikes that occurred.

times smaller than acoustic ranges for Level A harassment during installation of monopiles[21] (e.g., 2.29 vs. 5.25 km for high-frequency (HF) cetaceans in winter; see Tables 16 and 18 in Revolution Wind's application).

Further, it is unclear whether additional measurements would be required to be conducted beyond the first three piles, if subsequent piles need higher hammer energies or more strikes to be driven to depth or if a greater number of piles is driven on a given day than was previously measured [22]. All such circumstances must be considered to ensure that the model-estimated Level A and B harassment zones are not exceeded. For these reasons, the Commission recommends that in the final rule NMFS (1) specify which model-estimated zones (i.e., acoustic ranges, exposure ranges, mitigation zones, monitoring zones) and which metrics (i.e., flat $R_{max}$, flat $R_{95\%}$) should be compared to the in-situ Level A and B harassment zones, (2) specify which type of in-situ Level A harassment zone (i.e., acoustic or exposure ranges) should be calculated, and (3) require that additional in-situ measurements be conducted for monopiles that are not represented by the previous three locations (i.e., substrate composition, water depth) *or* by the hammer energies and numbers of strikes needed or number of piles installed in a given day.

*Level A and B harassment takes for impact pile driving of monopiles*—In addition to the potentially underestimated harassment zones, some of JASCO's assumptions used to seed its exposure modeling were questionable or inappropriate. For example, JASCO used seven-day simulations[23] for its exposure modeling to inform its take estimates rather than single-day simulations adjusted by the respective density and multiplied by the number of days of each activity (29 days of the highest mean density month; 87 Fed. Reg. 79117). Single-day simulations run 30 or 50 times per activity, species, and season are more consistent with other entities' methods for conducting exposure modeling and would reduce the variance and standard error in the predictions as compared to single seven-day[24] simulations.

NMFS also based the Level B harassment takes for WTG monopile installation on three piles being installed per day for 26 days. If only one (or two) piles ultimately is installed per day, then the numbers of Level B harassment takes would be underestimated[25]. This is contrary to the numbers of proposed takes being conservative and NMFS's assertion that the three pile-per day scenario was considered to have the greatest potential impact on marine mammals (87 Fed. Reg. 79117). Assuming three piles are installed per day is conservative for estimating takes for Level A harassment, but it is not conservative for Level B harassment. For simplicity, the number of

[21] Exposure ranges are smaller than acoustic ranges for Level B harassment too, but to a much lesser degree (e.g., 4.11 vs. 4.26 km for low-frequency (LF) cetaceans in winter; see Tables 20 and 17 in Revolution Wind's application, respectively).
[22] i.e., two or three instead of one monopile, 5,000 strikes instead of 10,740 strikes for one monopile, etc.
[23] Seven-day simulations are more relevant for continuous activities such as seismic surveys. They are not relevant to 4 hours of impact pile driving for each monopile, with up to 8 hours per day.
[24] Seven-day simulations should not be retained because it is time consuming to rewrite the code for single-day simulations and additional Monte Carlo simulations. Rather they should be retained because they reflect the proposed activities more accurately.
[25] NMFS acknowledged in the preamble to the proposed rule that it is unlikely that the three pile-per day installation rate would be possible consistently throughout the WTG construction phase (87 Fed. Reg. 79117), and Revolution Wind indicated in its application that it would take 9 hours to install a single pile under ideal conditions.

proposed takes during WTG monopile installation could be multiplied by three or recalculated based on 79 days of activities in the three highest mean density months.

Although JASCO estimated Level A harassment takes for numerous species[26] during impact installation of monopiles, NMFS did not propose to authorize those takes. NMFS proposed to authorize Level A harassment takes for humpback whales only and did not specify why the Level A harassment takes were discounted for impact installation of monopiles for the other species. This is curious given that the agency did specify in the preamble why Level A harassment takes were discounted for all of the other activities[27]. Revolution Wind indicated in its updated density and take estimate addendum that it would be monitoring the full extent of the Level A harassment zones for all of the other species and, therefore, it would prevent Level A harassment takes.

That approach contradicts how NMFS handled the Ocean Wind rulemaking. The Level A harassment zones for monopiles were smaller for Ocean Wind than Revolution Wind (1,650 vs. 2,660 km in summer, respectively) and the monitoring requirements for mitigation measure implementation are the same for both companies, yet NMFS still proposed to authorize Level A harassment takes for the very same species for Ocean Wind (except North Atlantic right whales; see Tables 18 and 20 at 87 Fed. Reg. 64928 and 64931, respectively). The agency should have done so for Revolution Wind as well, particularly given the lack of proven efficacy of the proposed mitigation measures that is discussed in detail in a subsequent section herein. Similarly, Level A harassment takes were not proposed for impact installation and removal of casings, while the Level A harassment zone for HF cetaceans is even larger at 3,950 m (Table 25 in Revolution Wind's application and Table 36 in the *Federal Register* notice).

In general, underestimation of takes is costly, both monetarily and time-wise, if the operator must shut down activities when the authorized number of takes is met and/or if any issued LOA must be revised. Other wind-energy operators have had to revise their incidental harassment authorization mid-authorization, and in some cases, twice when the authorized number of takes had been met (e.g., 86 Fed. Reg. 13695). Considering that delphinids have elicited authorization revisions in the past, NMFS should be ensuring that the number of takes to be authorized is sufficient. For example, 4,644 common dolphins were observed in the lease areas during combined HRG surveys for Revolution Wind and two other wind projects from September 2019 to September 2020 (Smultea Environmental Sciences, LLC 2020). However, NMFS estimated only 1,328 Level B harassment takes[28] for common dolphins during impact pile driving of monopiles (Table 16 in the *Federal Register* notice). The Commission is not convinced that the numbers of common dolphin takes are sufficient—for impact pile driving of monopiles or the other activities—given the size of the Level B harassment zones, the potential number of days of activities, and the known presence of delphinids in the area.

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[26] Takes of 7 fin whales, 61 minke whales, 18 North Atlantic right whales, 3 sei whales, 321 harbor porpoises, 5 gray seals, and 32 harbor seals were estimated (Table 16 in the *Federal Register* notice).

[27] Even though NMFS indicated that it did not fully account for the effectiveness of the proposed mitigation measures for the numbers of Level A harassment takes (except for North Atlantic right whales; 87 Fed. Reg. 79129), it did so explicitly for impact installation and removal of casings (87 Fed. Reg. 79123), UXO detonations (87 Fed. Reg. 79122), and HRG surveys (87 Fed. Reg. 79128) and implicitly for impact installation of monopiles (compare Table 16 to Table 32 in the *Federal Register* notice).

[28] NMFS proposed to authorize only 3,913 common dolphin takes for all activities that would be authorized (Table 33 of the *Federal Register* notice).

For these reasons, the Commission recommends that in the final rule NMFS (1) revise its take estimates for impact installation of 7/12-m monopiles based on the possibility that only a single pile is installed per day over 79 days rather than three per day over 26 days and (2) include the model-estimated Level A harassment takes of fin whales, minke whales, sei whales, harbor porpoises, gray seals, and harbor seals during impact installation of monopiles. The Commission also recommends that NMFS (1) include in the final rule a small number of Level A harassment takes of harbor porpoises during impact installation and removal of casings and (2) ensure that the numbers of Level B harassment takes of common dolphins are sufficient and increase the total number, as necessary, for the final rule. Additionally, the Commission recommends that NMFS determine whether Department of the Navy's (2017) group size estimates are more appropriate or reflective of expected group size estimates for Revolution Wind than those used in the proposed rule and if so, amend the numbers of takes accordingly in the final rule for all activities that would be conducted. Moreover, JASCO should strongly consider revising its exposure modeling to include single-day simulations for stationary, discrete sound sources and numerous Monte Carlo simulations (e.g., at least 30) for modeling reports that inform any future proposed rule.

*Mitigation and monitoring measures for impact pile driving of monopiles*—NMFS reduced the model-estimated number of Level A harassment takes of North Atlantic right whales during impact installation of monopiles based on the mitigation measures that Revolution Wind would be required to implement, including monitoring various mitigation zones and initiating a shut down if a right whale is detected at any distance using a combination of visual monitoring from the construction vessel, a secondary monitoring vessel stationed at 2.3 km in summer or 4.4 km in winter, and real-time passive acoustic monitoring (PAM; 87 Fed. Reg. 79134). If the intent is to minimize impacts on North Atlantic right whales as specified in the *Federal Register* notice (87 Fed. Reg. 79134 and 79152–79156), attempting to monitor a minimum assumed 3.8-km zone in the summer and 4.1-km zone in winter could prove difficult, and more so if the zones have been underestimated.

A single vessel stationed at 2.3 km would not be sufficient for monitoring the farther extents of the zones[29]—that is, the distance to the farthest extent of the Level A harassment zone would be 4.6 km and 6.1 km based on the Level B harassment zone. Less than half of the Level B harassment zone could be monitored in summer, with even less of it in winter. NMFS clarified in the preamble to the proposed rule that if, after SFV, harassment zones are expanded beyond an additional 1,500 m, additional PSOs would be deployed on additional platforms, with each observer responsible for maintaining watch in no more than 180° and of an area with a radius no greater than 1,500 m (87 Fed. Reg. 79145). Although NMFS seems to acknowledge the limitations of visual monitoring with that proposed mitigation requirement, the initial proposed observation areas do not conform to a radius of only 1,500 m[30]. Recently Oedekoven and Thomas (2022) estimated effectiveness of marine mammal observers (MMOs) to be 54 percent for detecting rorquals at 914 m or more, 31 percent for small cetaceans in pods of more than six, and 14 percent for small cetaceans in pods of six or fewer. The presumption that mitigation can be effective with visual observations alone is unsubstantiated.

[29] Since NMFS assumes that the zones are radii of circles.
[30] Which would equate to less than one third of the Level B harassment zone being monitored in summer and less than one quarter in winter.

To supplement visual monitoring, NMFS indicated that Revolution Wind plans to implement PAM arrays outside of the shut-down zone(s) to monitor animals entering the zone(s) (87 Fed. Reg. 79142) and proposed to require the PAM operator to implement a shut down if an animal occurred within 2.3 km of the pile driving platform in summer (4.4 km in winter; Table 34 in the *Federal Register* notice). However, Revolution Wind did not provide a PAM plan, it merely provided examples of PAM devices and capabilities in Appendix C of its application. Not requiring Revolution Wind to have a fleshed-out PAM monitoring plan runs counter to NMFS being able to assess whether the company would be able to implement the mitigation measures successfully and would be effecting the least practicable adverse impact on the species. Rather, NMFS proposed to require that Revolution Wind provide the PAM plan at least 180 days prior to installation of the first pile (section 217.275(c)(1)(vii) of the proposed rule). In addition, failing to require a PAM plan compromises the transparency of the public review process.

Since neither Revolution Wind nor NMFS provided information on the minimum number, type (e.g., moored, drifting, or towed), location, bandwidth/sampling rate, estimated acoustic detection range, or sensitivity of the hydrophones or the detection software (e.g., PAMGUARD) that would be used, it is impossible to determine whether Revolution Wind would be able to monitor effectively in real time the currently-estimated 3.8- and 4.1-km Level B harassment zones. This information is necessary to ensure that Revolution Wind can detect, classify, and localize North Atlantic right whales, as intended. NMFS also did not appear to consider how the direct strike pulses and reverberation from impact pile driving of monopiles could inhibit detection of marine mammal vocalizations, primarily those of right whales. The Commission recommends that NMFS require Revolution Wind to submit a PAM plan for monitoring pile-driving activities and allow for public comment prior to issuing any final rule. The PAM plan should include the number, type(s) (e.g., moored, towed, drifting, autonomous), deployment location(s), bandwidth/sampling rate, sensitivity of the hydrophones, estimated detection range(s) for ambient conditions and during pile driving, and the detection software to be used. Further, Revolution Wind and other wind energy applicants should consider whether vector sensors should be used in addition to hydrophones to enhance detections, particularly of those vocalizations that may be drowned out by the hammer strikes and resulting reverberation.

Similar to the PAM plan, Revolution Wind did not provide and NMFS did not require an SFV plan to be submitted for impact pile driving of monopiles before publishing the proposed rule. Instead, Revolution Wind will have to provide the SFV plan to NMFS at least 180 days prior to installation of the first pile (section 217.274(d)(3)(viii) of the proposed rule). In previous authorizations, the SFV requirements have been incomplete or incorrect. In this case, section 217.274(d)(3) of the proposed rule omitted the requirement to determine root-mean-square sound pressure level ($SPL_{rms}$) source levels and the specification that Level B harassment thresholds are based on behavioral disturbance. Section 217.275(d)(9)(i)[31] of the proposed rule also omitted the requirement to specify the cumulative SEL, ranges to the Level A and B harassment zones, and type(s) and location(s) of the sound attenuation systems in the interim SFV reports. In addition, NMFS did not specify a minimum number of hydrophones that Revolution Wind would be required to deploy for SFV. The Commission recommends that NMFS address the aforementioned issues and include the noted omissions in sections 217.274 and 217.275 of the final rule and require in the

[31] This section also apparently applies to UXO detonations.

final rule that Revolution Wind deploy a minimum of three hydrophones for SFV during impact pile driving of monopiles.

**UXO detonations**

*Behavior thresholds for explosives*—With respect to detonations, NMFS has again assumed that temporary threshold shift (TTS) and brief startle responses, not behavioral disturbance, are the most likely impact to result from the proposed underwater detonations (87 Fed. Reg. 79104). The Commission has disagreed for many years with NMFS's stance that single detonations do not have the potential to cause behavioral disturbance (see the Commission's 6 September 2022 letter detailing this issue). Although animals may not have been observed to exhibit significant behavioral responses to temporally- and spatially-isolated detonations in the past, sufficient monitoring also has not occurred to verify that behavioral responses have not occurred. Evidence also has yet to be provided supporting that an animal exhibiting a significant behavioral response to two 5-lb charges detonated within a few minutes of each other would not exhibit a similar response to a single detonation of 100 lbs., let alone to detonations of up to 1,000 lbs.

Changing behavior state, ceasing a vital function (e.g., feeding, resting, nursing), and/or avoiding the area are behavioral responses that are likely to occur, particularly when a 1,000-lb UXO detonates near a marine mammal. In fact, NMFS indicated in the preamble to the proposed rule that (1) behavioral avoidance alters energetic expenditures, as energy is required to move away from a sound source and (2) marine mammals disturbed by anthropogenic sound are commonly reported to shift from resting to active behavioral states, implying an energy cost (87 Fed. Reg. 79097). NMFS also specified that lower-level physiological stress responses (e.g., change in orientation, startle response, change in respiration, change in heart rate) are likely to co-occur with behavioral modifications, and takes by Level B harassment could then have a stress-related physiological component (87 Fed. Reg. 79149). Continuing to deny that a single explosive event, including that of a 1,000-lb UXO, has the potential to cause behavior takes of marine mammals underwater is illogical and unsubstantiated, especially as NMFS routinely authorizes behavior takes of marine mammals associated with exposure to *single* in-air explosive events (e.g., 84 Fed. Reg. 28462). The Commission again recommends that NMFS estimate and authorize Level B harassment behavior takes of marine mammals, in addition to TTS takes, for UXO detonations in the final rule.

*Efficacy of sound attenuation systems for UXO detonations*—Revolution Wind plans to use a sound attenuation system[32] during all UXO detonations and presumed, along with NMFS, that it would achieve at least a 10-dB sound reduction (87 Fed. Reg. 79120). NMFS also indicated that the potential for mortality and non-auditory injury during UXO detonations is considered *de minimis* (87 Fed. Reg. 79120). Mortality and non-auditory injury may be unlikely, but they are not *de minimis*. Furthermore, the potential for any of the various types of taking relies heavily on the assumed 10-dB sound reduction.

That assumption was based upon Bellmann et al. (2020) and Bellmann (2021)[33]. Bellmann et al. (2020) mentioned UXO detonations only once—

[32] Termed noise mitigation device and noise abatement system in the preamble to and the proposed rule.
[33] This reference was cited incorrectly as Bellmann and Betke (2021) in the preamble to the final rule.

> Big Bubble Curtains [BBCs] were already successfully applied in Europe during detonations of ammunition dumpsites (UXO clearance) in up to 70 m water depth in the North- and Baltic Sea. However, in most cases, no underwater noise measurements were carried out to evaluate the applied Big Bubble Curtain.

Successful deployment and efficacy are not synonymous. Bellmann (2021) indicated that currently the only reliable, offshore-tested noise mitigation system for UXO clearance is reduction of charge weights, which is not feasible with UXOs, and that the typical charge weight of UXOs was 10 kg. He went on to state that the only technically feasible and offshore-reliable *possibility* to reduce underwater sound during clearance of UXOs is the application of an optimized single or double BBC (DBBC). UXOs in Europe also have been degrading in water for the last 75 years, compromising the integrity of the TNT-equivalent material. Although 750-kg UXOs may have a charge weight of only 10 kg or less in European waters, that might not be the case in U.S. waters. NMFS indicated that UXOs in U.S. waters typically could be left behind following Navy military training, testing, or other operations (87 Fed. Reg. 79075). Those activities are ongoing.

In addition, Bellmann (2021) discussed modeled and measured detonations of 100 g, 5 kg, and 10 kg, which are much less than the 1,000-lb, or 454-kg, UXO that Revolution Wind could detonate. Bellmann (2021) noted that an overall SEL reduction of 11 dB was observed with the first application of a BBC during UXO clearance, but did not specify how large of a charge was detonated. Since Bellmann (2021) was based on 10-kg (or less) charges, one can assume that the measurements of UXO clearance using a BBC were for small charges as well.

BBCs attenuate HF sound (<1 kHz) more efficiently than LF sound (Bellmann et al. 2020) that corresponds to most of the UXO energy. Further, neither reference discussed whether the shockwave from the UXO detonation would disrupt or displace the bubble curtain. Shockwaves travel at supersonic speeds and would reach the BBC before the sound. Placement of the BBC around a UXO detonation was not discussed in any of Revolution Wind's documents but would greatly affect whether and to what degree the BBC could attenuate the sound.

Bellmann (2021) also indicated that currents >2 knots led to a reduction of sound attenuation that cannot be resolved with additional compressed air or larger distances to the source and that the overall achieved sound reduction of a BBC depends significantly on the configuration and application of the BBC. If neither is optimized, then the sound reduction decreases significantly. The Commission finally notes that NMFS would not require Revolution Wind to deploy a dual sound attenuation system in the proposed rule (see section 217.274(f)(1)(iii)), which is inconsistent with requirements for impact pile driving. Given the lack of proven efficacy and limitations of use of sound attenuation systems during UXO detonations, the Commission recommends that in the final rule NMFS re-estimate the various mortality, Level A harassment, and Level B harassment zones and mitigation and monitoring zones based on 0 dB of sound attenuation and re-estimate the numbers of takes accordingly, increasing to group size where necessary. The Commission also recommends that in the final rule NMFS require Revolution Wind to use a dual sound attenuation system during UXO detonations and prohibit Revolution Wind from conducting UXO detonations when currents are greater than 2 knots.

*Level A harassment takes for UXO detonations*—Similar to pile driving, NMFS discounted the number of model-estimated Level A harassment takes[34] for fin whales, humpback whales, minke whales, and sei whales[35] during UXO detonations[36], citing that Revolution Wind proposed mitigation and monitoring measures intended to avoid Level A harassment[37] takes of most species (see Tables 23 and 32 in the *Federal Register* notice). The intent of mitigation measures is not comparable to the efficacy of such measures. As stated previously herein, the efficacy of visual monitoring is not 100 percent and the extent to which the PAM that would be employed can detect marine mammals is unknown. In this instance, NMFS has increased the clearance zones (compare Tables 18 and 19 to Table 37 in the *Federal Register* notice) to 10 km for LF and HF cetaceans, 5 km for phocids, and 2 km for mid-frequency cetaceans. NMFS would require that six PSOs and one PAM PSO monitor before, during, and after the detonation—two PSOs on two different vessels and two PSOs in an aircraft if the clearance zone is greater than 5 km. That number of PSOs would not guarantee that all cetaceans are sighted, similar to HF cetaceans and phocids for which NMFS proposed to authorize Level A harassment takes. Minke whales are difficult to observe out to 10 km with only three platforms, and dolphins could occur within the Level A harassment zone undetected depending on group size and the speed at which they are traveling, as well as where the platforms are surveying (e.g., Oedekoven and Thomas 2022). For these reasons, the Commission recommends that NMFS authorize Level A harassment PTS takes for fin whales, humpback whales, minke whales, common dolphins, bottlenose dolphins, and Atlantic white-sided dolphins during UXO detonations and increase to group size, if needed, in the final rule.

*PAM and SFV plans for UXO detonations*—Similar to impact pile driving, Revolution Wind did not provide and NMFS did not require a PAM or SFV plan to be submitted for UXO detonations before publishing the proposed rule. By not requiring Revolution Wind to have a detailed PAM monitoring plan, it is unclear how NMFS will be able to assess whether the company would be able to implement the mitigation measures successfully and would be effecting the least practicable adverse impact on the various species, including North Atlantic right whales. Rather, NMFS proposed to require that Revolution Wind provide the PAM plan at least 180 days prior to any UXO detonations (section 217.275(c)(3)(iv) of the proposed rule). The Commission recommends that NMFS require Revolution Wind to submit a PAM plan for monitoring UXO detonations and allow for public comment prior to issuing any final rule. The PAM plan should include the number, type(s) (e.g., moored, towed, drifting, autonomous), deployment location(s), bandwidth/sampling rate, sensitivity of the hydrophones, estimated detection range(s) for ambient conditions, and the detection software to be used.

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[34] Based on permanent threshold shift (PTS). The Commission notes that two of the PTS $R_{max}$ zones and two of the TTS $R_{max}$ zones are incorrect in Tables 19–21 of the *Federal Register* notice. See Tables 42–47 in the underwater acoustic modeling of UXO detonations report for the correct distances that should be included in the preamble to the final rule.

[35] Consistent with NMFS rounding takes up for other activities, Level A harassment PTS takes of common dolphins, bottlenose dolphins, and Atlantic white-sided dolphins should have been authorized (e.g., see Level B harassment takes for humpback whales in Table 16 of the *Federal Register* notice).

[36] NMFS did propose to authorize Level A harassment PTS takes of harbor porpoises, gray seals, and harbor seals though.

[37] NMFS appears to contradict this statement in the preamble to the proposed rule by stating that, given the proposed mitigation measures, it is unlikely that any of the more serious injuries or mortality would result from any UXO detonations and PTS, TTS, and brief startle responses are the most likely impacts to result from UXO detonations (87 Fed. Reg. 79104).

For the SFV plan, Section 217.274(f)(5)(i) of the proposed rule incorrectly specified the source levels as 'peak and cumulative sound exposure level', instead of impulse (Pa-sec), $SPL_{peak}$, and SEL for UXO detonations and omitted the requirement to provide ranges to the mortality isopleths. In addition, Section 217.275(d)(9)(i) of the proposed rule omitted the requirement to specify impulse and cumulative SEL, ranges to the mortality and Level A and B harassment zones, and type(s) and location(s) of the sound attenuation systems in the interim SFV reports for UXO detonations. A minimum number of hydrophones that Revolution Wind would be required to deploy was not specified, nor whether a pressure transducer would be required to capture the fast rise times and overpressure produced from a UXO detonation that are crucial for measuring impulse and $SPL_{peak}$ metrics. The Commission recommends that NMFS address the aforementioned issues and include the noted omissions in sections 217.274(f)(5) and 217.275(d)(9) of the final rule and require in the final rule that Revolution Wind deploy a minimum of two hydrophones and one pressure transducer for SFV during UXO detonations.

*Mitigation and monitoring measures for UXO detonations*—Section 217.274(d)(5)(ii) of the proposed rule would require that PAM operators review acoustic data from at least 24 hours prior to pile driving. As a precautionary measure, the Commission recommends that NMFS require Revolution Wind to have PAM operators also review acoustic data for at least 24 hours prior to UXO detonations, when available, in the final rule.

**Monitoring of wind turbine operational underwater sound**

The Commission notes that section 217.274(d)(3)(ix) of the proposed rule would require the SFV plan to include how operational sound would be monitored in order to estimate source levels and transmission loss associated with wind turbine operations. Although Revolution Wind would be required to report the source level at 10 m and transmission loss, it also should specify the sound levels measured at 50 m, 100 m, and 250 m from the wind turbine. In addition, Revolution Wind would be required to provide operational parameters, such as direct drive/gearbox information and turbine rotation rate, as well as sea state conditions and nearby anthropogenic activities. However, none of the SFV information would be required to be included in the final report. As such, the Commission recommends that NMFS specify in section 217.275((d)(9)(ii) of the final rule that the final SFV report must include source levels at 10 m during wind turbine operations, received levels at 50 m, 100 m, and 250 m from the wind turbine, operational parameters (i.e., direct drive/gearbox information, turbine rotation rate), sea state conditions, and any nearby anthropogenic activities. These reporting requirements would be in addition to those already specified in sections 217.275(d)(9)(ii)(A) to (K) of the proposed rule that are applicable to wind turbine operational sound.

Monitoring operational sound would be useful for determining actual sound levels associated with various types of wind turbine configurations and informing mitigation measures that may be effective at reducing individual turbine or overall wind farm sound levels. For example, studies indicate that a 10-dB reduction in sound levels may be possible by using direct drive technology rather than gear boxes (Stöber and Thomas 2021). The Commission recommends that NMFS require wind farm applicants to include monitoring of operational sound in their SFV plans in all future proposed rules.

**General mitigation and monitoring measures**

The following omissions and errors were noted in the proposed rule and should be addressed in the final rule.

- Section 217.272(a) should also specify impact pile driving and removal of casing pipes and vibratory pile installation or removal of goal posts.
- Section 217.272(b) omitted impact removal of casing pipes.
- The terms 'small odontocetes', 'delphinids and harbor porpoises', and 'dolphins and porpoises' were used interchangeably throughout the various mitigation measures in section 217.274.
- The terms 'seals' and 'pinnipeds' were used interchangeably or omitted altogether from the various mitigation measures in section 217.274.
- Section 217.274(d)(3)(vii) contradicts section 217.274(f)(5)(1), which specifies that SFV must be conducted for each UXO detonation.
- Section 217.274(f)(2) specified that seasonal restrictions for UXO detonations would be in place from 1 December through 31 April; however, April has only 30 days.

Please contact me if you have questions regarding the Commission's recommendations.

Sincerely,

Peter O. Thomas, Ph.D.,
Executive Director

cc: Amy Scholik-Schlomer, NMFS Office of Protected Resources
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