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Mayflower In-Air Acoustic Assessment Document Review

Prepared for:

Falmouth, MA

Exponent

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Mayflower In-Air

Prepared for:

Falmouth, MA

Prepared by:

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Scope and Limitations

At the request of the Town of Falmouth, Exponent submits this preliminary review of the In-Air Acoustic Assessment provided by Mayflower Wind. The document was reviewed in the context of providing "actional commentary" to allow the Town of Falmouth to identify areas of concern related to the Mayflower Wind proposal as well as aspects of design and mitigation that could potentially be proposed to "better protect the health and environment" of the Town of Falmouth.

The town of Falmouth, MA, requested that Exponent perform a high-level review and comparative analysis of the noise analysis prepared by Mayflower Wind Energy LLC ("Mayflower") for the Mayflower Wind Project. The scope of services performed during this investigation may not adequately address the needs of other users of this report, and any re-use of this report or its findings, conclusions, or recommendations presented herein for purposes other than intended for Project permitting are at the sole risk of the user.

The role of Exponent in this project is advisory in nature, and the opinions, analyses, conclusions, results, suggestions, and the like, hereafter referred to as "work products," must be assessed by the town of Falmouth with respect to its services. Falmouth assumes full and complete responsibility for all uses and applications of work products, or failure to use work products, as well as for the application of any data captured through use of the work products. Exponent involvement is based on scientific literature, industry standards, and the training, education, and experience of the Exponent consulting staff. Work products do not represent safety certification of any sort.

The findings presented herein are made to a reasonable degree of engineering and scientific certainty. Exponent reserves the right to supplement this report and to expand or modify opinions based on review of additional material if it becomes available.

Executive Summary

Mayflower conducted on-site noise measurements at the proposed receiver locations, simulated the noise levels associated with operation and construction of the proposed Wind Energy System (WES), and determined the noise mitigation measures required to meet the identified regulations. The analysis concluded that a series of noise barriers ranging from 6 ft to 22 ft tall would be required at the Lawrence Lynch and Cape Cod Aggregates substation sites to maintain operational noise levels within 10 dBA of ambient levels as required by 310 Code of Massachusetts Regulations 7.10 (310 CMR 7.10). Unmitigated construction of the Worcester Avenue and Shore Street landfall installation sites would create substantial noise levels, exceeding 100 dBA. Noise abatement provided by a 16 ft tall noise barrier and equipment silencers would reduce the noise to a generally acceptable level of 65 dBA (no federal, state, or local regulations were identified as applicable regarding construction noise). No noise analysis was performed on off-shore sites, as they are sufficiently far away from noise receptors. Detailed analyses of the noise due to installation of onshore export cables and onshore substation construction have not been conducted but are expected to be completed upon selection of the required equipment and their associated locations, and upon development of a detailed construction plan.

Exponent identified multiple concerns regarding the acoustic measurement techniques in addition to the underlying assumptions in the model and analysis. The items listed below represent key concerns.

(1) Relevant regulations are missing from Mayflower's analysis. The Town of Falmouth's Zoning Bylaw § 240-9.8D is not considered, which sets forth a more conservative limit of 6 dBA on the increased noise level of WES projects. Additional noise mitigation measures beyond those currently proposed would be required to achieve compliance with this regulation.

(2) The methods used by Mayflower to determine the existing ambient conditions at the substation sites do not properly account for potential high frequency contributions from common nighttime sources such as insects and wind noise.

(3) The potential for nighttime operation of horizontal directional drilling equipment at the landfall sites was not addressed.

Project Background and Description

Wind power is one of the fastest growing renewable energy sources, in part due to its cost-effectiveness and low land footprint; however, one potential drawback is the noise produced by both the blade aerodynamics and the generator[1]. U.S. cities are quickly adapting to the increased need and demand for renewable energy sources. On May 7th 2021, the Commonwealth of Massachusetts submitted a request for proposals for Long-term Contracts for Offshore Wind Energy Projects as a part of Massachusetts' 83C III offshore wind energy initiative, which was awarded to Mayflower Wind Energy LLC (hereby referred to as Mayflower) and Vineyard Wind LLC. Mayflower's proposed project is slated to supply 400 MW of power to the electric grid at two delivery points, one in Falmouth, and another in Somerset. As a part of the submitted proposal, Mayflower assembled an In-Air Acoustic Assessment report which evaluated the impact of airborne noise due to the planned wind turbine generator (WTG) layout and the landing(s), onshore substation, and Falmouth Point of Interconnection[2].

The proposed design considered three potential landfall locations in Falmouth: Worcester Avenue (preferred), Shore Street, and Central Park. The Falmouth landfall location would support up to 12 onshore export cables carrying a nominal voltage of 200-345 kV. An onshore air-insulated or gas-insulated substation, requiring up to 26 acres of land in total, would be located in either Lawrence Lynch (preferred) or Cape Cod Aggregates. The substation is responsible for transforming the power supplied by the wind turbines (275 kV) to a voltage that is compatible with the grid (345 kV). Overhead transmission lines up to 8.2 km in length and carrying a nominal voltage of 345 kV would connect the onshore substation to the proposed point of interconnect (POI) in Falmouth Tap.

Regulations

[1] "Advantages and Challenges of Wind Energy", Office of Energy Efficiency & Renewable Energy, https://www.energy.gov/eere/wind/advantages-and-challenges-wind-energy
[2] "Final In-Air Acoustic Assessment Report", prepared by AECOM for Mayflower Wind Energy LLC, https://app.box.com/s/bh1j1s2a45fkkns3fyezxai5vcmrsvv2

Federal, state, and local regulations should be considered when assessing environmental noise impacts. Environmental noise impacts are typically assessed by two methods: comparison of the increase above the background sound level to a criterion and comparison of the noise increase to a specified absolute level. Comparison tobackground noise levels allows for ease of communication. This approach is widely accepted as best practice and forms the basis of Massachusetts policy. However, consideration of the increase in noise from existing ambient levels should be supplemented with absolute criteria, such as that from the US EPA, to ensure that gradual increases in the ambient sound level do not occur over time.

The primary responsibility of regulating noise has been delegated to state and local governments, but the federal Noise Control Act of 1972 and the Quiet Communities Act of 1978 remain in effect today. The Noise Control Act of 1972 enables federal agencies to regulate noise sources that risk the health and safety of the public, which includes mechanical equipment and construction machinery, motor vehicles, and commercial products. To protect public health and welfare regarding interference with outdoor activity, speech intelligibility, and annoyance, the EPA specified a day-night average sound level of 55 dBA for residential areas[3]. This limit should be considered regarding the operational noise from the substation, however, this guidance is not typically applied to short-term activities, such as construction activities.

At the state level, noise sources must abide by the regulations specified in 310 Code of Massachusetts Regulations 7.10 (310 CMR 7.10). Noise sources are considered to violate this regulation if they increase broadband noise levels by more than 10 dBA above ambient levels (measured as the lowest hourly L_{90} in dBA), or produce a pure tone condition at the property line and nearest residential noise receiver.

Local regulations in the Town of Falmouth Zoning Bylaws § 240-9.8D, state that Wind Energy Systems (encompassing transmission, storage equipment, substations, transformers, service and access roads, and wind turbines) shall *“not exceed increases in broadband sound levels by more*

[3] “Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety”, U.S. Environmental Protection Agency, https://www.rosemonteis.us/sites/default/files/references/usepa-1974.pdf

than 6 A-weighted decibels or "pure tone" sound levels by more than 3 A-weighted decibels over ambient sound levels at the property line.".[4]

Assessment Methodologies

Mayflower's noise assessment consisted of a three-prong analysis. First, the existing noise conditions at each proposed substation location were determined by taking sound level measurements over the course of 48 hours at two noise sensitive receiver locations, and evaluating the minimum hourly L_{90} value. These values were used to identify whether the modeled noise levels associated with the project operation were within the allowable limits specified by 310 CMR 7.10. Note that noise measurements were not taken at off-shore locations and hence were not incorporated into the analysis, as they are planned to be at least 20 miles away from the nearest noise sensitive receiver and their contributions would not be significant.

Step two consisted of a preliminary noise analysis using CadnaA software, following the ISO 9613-2 standard, to simulate the operational noise of the finalized plans. Only noise levels for dominant noise sources were considered in the model, including but not limited to onshore transformers, wind turbine generators, and construction equipment. Quieter equipment was ignored inthe assessment which may impact the overall results of the analysis. The overhead transmission lines between the substation and POI were neglected in the analysis and although their noise levels are unlikely to exceed regulations, the corona noise may be a nuisance. The criteria for sufficient noise mitigation features (i.e. barrier height and width) were identified in instances where the predicted noise levels at the receivers exceeded 10 dBA over existing conditions. Note that a maximum ground factor of 0.5 is commonly specified in models to obtain conservative estimates of noise impacts, which is lower than the 0.6 used in the Mayflower noise assessment.

Finally, construction noise levels at two out of three of the landfall sites were modeled and compared to a commonly accepted noise limit of 65 dBA L_{eq} for residential daytime levels, although note that Mayflower's report found no applicable federal, state, or local regulations

[4] Town of Falmouth MA Zoning Bylaw, pg. 94, https://www.falmouthma.gov/DocumentCenter/View/8559/Falmouth-Zoning-Bylaw-Recodification-Clean-Copy-for-April-2021-Town-Meeting

regarding construction noise. A substantial amount of construction-related noise would be due to horizontal directional drilling at the landfall sites.

Existing Noise Conditions

Existing noise conditions were measured at the Lawrence Lynch and Cape Cod Aggregates locations, at the property line and nearest residential noise receptor. The Mayflower report notes that *"intermittent construction vehicle operations and back-up alarms from the Lawrence Lynch site"* and *"distant mechanical noise from the main Cape Cod Aggregates facility"* were present during the long-term existing noise condition measurements at the respective locations. As the metric for comparison is the lowest hourly L_{90} (in dBA), and the measurements covered the span of 48 hours, the increased noise from intermittent construction during measurements is not expected to significantly bias the resulting analysis. The minimum hourly L_{90} values at Lawrence Lynch receivers LLG-LT1 and LLG-LT2 were 38.5 dBA and 44.6 dBA respectively, whereas the minimum hourly L_{90} values for Cape Cod Aggregates receivers CCA-LT1 and CCA-LT2 were 40.1 dBA and 34.9 dBA respectively.

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The initial noise analysis, which contained no noise mitigation features, showed that the noise levels for all receivers at both proposed substation locations exceeded an increase of 10 dBA from the existing conditions. To bring the modeled noise levels within a 10 dBA increase, construction of noise barriers would be required. The Lawrence Lynch location would require a 6 ft tall barrier along the northwest retaining wall to meet state regulations. The Cape Cod Aggregates site would require one 22 ft and six 16 ft barriers, localized around equipment. Neither modeled scenario abides by the 6 dBA increase from existing conditions specified in the Town of Falmouth's Zoning Bylaw § 240-9.8D, which would require additional noise mitigation. Mitigating the source is often the most effective means of reducing noise, but alternate equipment was not considered in the Mayflower noise assessment. Another option would be to purchase the surrounding property, which would increase the distance between the noise source and the nearest property line or noise receptor.

Three different construction noise scenarios were discussed. Detailed analyses of the noise due to installation of onshore export cables have not been conducted, but are expected to be completed upon finalizing the required equipment and their associated locations. The noise impact associated with this is expected to be small. Detailed analyses of the noise associated with onshore substation construction is also planned for future analysis, upon development of a detailed construction plan. Finally, a complete noise analysis was conducted at both the Worcester Avenue (preferred) and Shore Street (alternate) landfall installation sites. While there are no policy limits that apply to the construction of the proposed project, a commonly accepted noise limit of 65 dBA L_{eq} for residential daytime levels was used for comparison purposes. The model shows that without noise mitigation, some receivers may experience over 100 L_{eq} dBA (about as loud as shouting into an ear, or a power lawn mower 3 ft away). The model showed that the construction noise levels could be reduced to the commonly accepted 65 dBA level, by incorporating equipment silencers in addition to a 16 ft tall temporary construction noise barrier.

Identified Areas of Concern

Relevant regulations appear to be missing from the in-air acoustic assessment, which impacts the allowable noise introduced by the Project. The regulation used in the report's assessment is less conservative, likely leading to an underestimate of the potential impacts.

(1) The Mayflower assessment deemed that no federal regulations were relevant to the in-air acoustic aspect of the Project; however, the EPA specifies a maximum day-night average sound level of 55 dBA for residential areas.

(2) The Town of Falmouth's Zoning Bylaw § 240-9.8D was not considered, which sets forth a limit that is more conservative than the state regulation for the increased noise level of WES projects (an increase of 6 dBA versus 10 dBA above existing conditions). This bylaw specifies that it supersedes more lax requirements from other authorities.

Two primary concerns arose regarding the data collection of existing ambient noise conditions. The results of the acoustic assessment and mitigation development hinge on the accuracy of these results; hence, ensuring due diligence is followed in these methods is critical.

(1) Meteorological conditions were measured at the beginning of each measurement only, however it is common best practice to record meteorological data during the entire measurement period. The actual wind speeds at the measurement location during the 48 hour measurement period are unknown, but noise from wind artificially inflates ambient measurements and all data taken during wind speeds exceeding 5 m/s should be excluded from analyses per ANSI S1.18.[5]

(2) The sound level was not ANS-weighted[6] to remove the effects of high-frequency sounds such as insects, birds, and wind-induced noise, which can substantially affect the A-weighted sound pressure levels in quiet, natural, and residential areas. Following this standard approach may lower the existing ambient level and require more mitigation of the substation noise per the state of Massachusetts regulation.

Other general concerns include:

(1) Horizontal directional drilling frequently involves 24 hour operation[7], yet the Mayflower noise assessment does not acknowledge or propose nighttime criteria for HDD operations at the landfall site. Although all of the construction equipment may not need to operate overnight, the proposed landfall sites appear to be within 100 ft of residential areas and are susceptible to noise disturbances.

(2) No justification was provided for neglecting the tonal assessment to ensure that operation or construction does not produce a "pure tone" condition in violation of regulation 310 CMR 7.10.

(3) While we acknowledge that this is a preliminary assessment, the report has an overall lack of detail regarding specifications of equipment and mitigation. Mufflers, barriers, and other

[5] American National Standards Institute (ANSI). 2004. American National Standard – Procedures for Outdoor Measurement of Sound Pressure Level: ANSI/ASA S12.18-2004.

[6] American National Standards Institute (ANSI). 2014a. Methods to Define and Measure the Residual Sound in Protected Natural and Quiet Residential Areas: ANSI/ASA S3/SC1.100-2014/ANSI/ASA S12.100-2014.

[7] "About Horizontal Directional Drilling", Massachusetts Water Resource Authority, March 2004

mitigation should be described more thoroughly. For example, a common specification for effective barriers is that they provide a minimum sound transmission coefficient of 30 decibels and a minimum noise reduction coefficient of 0.85

(4) Quieter equipment was not considered as a potential mitigation strategy, but will often improve conditions over a wider area than barriers, which are targeted to specific receptor locations.

Author Biographies

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Managing Engineer, Mechanical Engineering

Dr. Mennitt is a mechanical engineer with expertise in the characterization, design, and modeling of acoustical environments and devices. He has over 15 years of experience in acoustics, environmental noise, and noise control. Dr. Mennitt was awarded his B.S. and Ph.D. in Mechanical Engineering by the Virginia Polytechnic Institute and State University. Dr. Mennitt has worked in partnership with federal agencies to assess environmental noise and the consequences of noise exposure to humans and ecological systems. His research has involved the spatiotemporal patterns of environmental sound on landscape scales, predictive modeling of acoustic propagation, and the design of acoustical devices. Dr. Mennitt is a certified Occupational Hearing Conservationist and a member of the Acoustical Society of America and Institute of Noise Control Engineering.

Lawren Gamble, Ph.D.

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Dr. Gamble specializes in the analysis and testing of fluid structure interactions which incorporates multi-disciplinary knowledge across the fields of mechanical engineering and fluid mechanics. Her experience extends to both computational methods, such as finite element analysis and computational fluid dynamics, in addition to experimental methods and validation. She has extensive experience in data acquisition of multi-physics problems, 3D printing and additive manufacturing, and wind tunnel testing. Her breadth of experience also extends to vibration testing, unmanned aerial vehicle wing design and analysis, smart and shape memory material applications, composite materials, and digital imaging. She has applied her expertise in these areas to projects on modal analysis of 3D printed piezoelectric sensors, and morphing aero-control devices in aircraft and automobiles.

END OF REPORT