Docket No. 7156
Exhibit UPC-Cross-PG16
Admitted: ____________

Appendix 5.11-A

Noise Report

Appendix 5.11 - A

This Appendix contains the full technical analysis of potential noise effects from the Project and applicable regulatory requirements. The information contained in this section was obtained from review of existing data available for the Project Area, including above water and underwater sound monitoring, and from acoustic modeling. The Project has been planned, sited, and designed to avoid or minimize acoustic effects. The findings demonstrate there will be no adverse sound effects on humans or wildlife from the Project. While temporary and limited sound impacts are anticipated during construction, measures will be implemented to prevent and minimize these impacts. Potential impacts and mitigation measures are discussed below in Sections 4 and 5.

1.0 Introduction and Regulatory Requirements

As specified in the USACE scope, the noise analysis discussed in this section includes an assessment of the magnitude and frequency of underwater noise and vibration. The potential for adversely affecting fish and marine mammal habitats and migration is discussed in Sections 5.4 and 5.5 of the Draft EIS that deal with Finfish Resources and Protected Marine Species, and a summary of those results is given at the end of this Appendix.

The MEPA Scope requires baseline sound level monitoring at the nearest representative locations along the south coast of Barnstable and Yarmouth and the east coast of Martha's Vineyard to determine whether sound from the Project will be measurable above background noise levels. In addition to baseline monitoring, acoustic modeling of potential sound effects was performed and the results are presented below. This section also addresses the ability of the Project to meet the Community Sound Level Criteria contained in the MADEP Noise Policy (DAQC Policy 90-001).

1.1 Acoustic Concepts

The loudness of a sound is dependant on the radiated sound power of the source and the propagation and attenuation characteristics of the medium that the sound energy passes through. For airborne and underwater sound the standard unit of measurement is the decibel (dB), a logarithmic scale formed by taking 20 times the $\log_{10}$ of a ratio of two pressures: the measured sound pressure divided by a reference sound pressure. Above air sound is referenced to 20 μPa[1], while underwater sound is referenced to 1 μPA. As a result, an identical sound pressure wave in air and underwater is recorded differently in the two fluids. For example, a sound pressure of 80 dB in air is equivalent to 106 dB underwater, i.e., the underwater scale is shifted 26 dB higher than the air scale. There are also substantial differences in ambient (background) sound levels in air and in the ocean, and in the frequency weighting that is used in the two media. Thus, the reader should not try to equate dB levels reported for water with those in air, or vice-versa.

The human ear can perceive sounds in a frequency range from about 20 to 20,000 Hertz (Hz),[2] with hearing sensitivity greatest in the mid-range of 1,000 to 4,000 Hz. While the threshold of hearing is 0 dB in the mid-range, it rises rapidly for lower frequencies of sound, and very low frequency sounds below 20 Hz are essentially inaudible. Data from recent hearing threshold studies[3, 4] have been compiled to produce Table 1 which gives the hearing threshold for the human ear at frequencies from 16 to 16,000 Hz.

To account for the human ear's sensitivities to certain frequencies, an A-weighting filter is commonly used for describing environmental sound levels. A-weighting filters the frequency spectrum of sound levels as the human ear naturally does (attenuating low and high frequency energy similar to the way people hear sound). Sound levels that are A-weighted to reflect human response are presented as dBA (also as "A" in tables and graphs). The hearing capabilities of and the frequency responses of marine mammals vary widely. Therefore, underwater sound levels are presented as unweighted or linear dBL (also as "L" in tables and graphs). For both airborne and underwater sound, the frequency component of the measured sound is important in the analysis. Frequency information has been provided as sound spectrograms by 1/3 octave frequency bands for the airborne and underwater sound level events.

[1] MicroPascals = 10^{-6} Newton/m^2.
[2] The frequency unit Hertz is equivalent to cycles per second.
[3] Bies, D. and Hansen, C., Engineering Noise Control, Theory and Practice, 2nd Ed., Chapman & Hall, New York, 1996, p. 55.
[4] Berglund, B., Hassmen, P., and Job, R., "Sources and effects of low-frequency noise," J. Acoust. Soc. Am., 99(5), May 1996, p. 2986.

The logarithmic decibel scale compresses the full range of acoustic energy into a compact linear scale, ranging from 0 dB, the level considered to be threshold of human hearing, to 120 dB considered to be the threshold of pain, see Table 2. Negative decibels are sound pressure levels below the reference pressure. When two separate sounds are added together, the result in decibels is different than one might expect because of the logarithmic scale. For example, if a sound of 70 dB is added to another sound of 70 dB, the total is only a 3-decibel increase (or 73 dB), not a doubling to 140 dB. Thus, every 3 dB increase represents a doubling of sound energy. For broadband sounds, a 3 dBA change is the minimum change perceptible to the human ear, a 5 dBA change is noticeable and a 10 dBA change sounds twice (or half) as loud.[5]

According to ANSI standards, an audible pure tone occurs when a 1/3-octave band in the time-averaged (L_{eq}) spectrum formed by adding the new sound to the existing baseline levels is higher than the numerical mean of the two adjacent bands by 5 to 15 dB, with the threshold of 5 dB corresponding to high frequencies (> 500 Hz) and the 15 dB threshold corresponding to low frequencies (< 125 Hz).[6] The definition of a pure tone in the DEP Noise Policy is slightly different; it uses whole octave bands and a 3 dB threshold (see Section 1.2). The ANSI 1/3-octave band definition of pure tone was used in this analysis.

The air acoustic environment near the Project site results from wind and wave sound as well as sound from vessels, recreational boats and over-flying aircraft. Moving inland, other sources associated with human activity are added in, principally motor vehicle traffic and commercial activity. Typical airborne sound levels are presented in Table 2.

For underwater sound, the typical measurement range of interest is from 80 dBL (still water conditions) to upwards of 180 dBL, generally thought to be the threshold level for preventing injury or harassment to marine mammals and sea turtles.[7] The ambient sound in the sea comes from many sources, natural and man-made, including turbulence in ocean currents, tides, surface waves, cavitations (collapse of air bubbles) in near-surface waves, low-level seismic activity, sea animals, and ship traffic. The ambient underwater sound level is highly variable in time and by location. Just as one example, a one-knot current can produce turbulent pressure changes (sound waves) of 116 dBL.[8] Typical ambient sound levels in Nantucket Sound are 95-115 dBL for winds of five to 30 mph.

Sound levels can be measured and presented in various forms. The most common sound metrics used in community impact assessments are the equivalent sound level (L_{eq}), the maximum sound level (L_{max}), and the background sound level (L_{90}). The L_{eq} is the energy averaged A-weighted sound level that includes both steady background sounds and transient short-term sounds. The L_{eq} equals the level of a steady sound, which when averaged over the sampled time period is equivalent in energy to the time-varying (fluctuating) sound level which actually occurred during the same time period. The L_{eq} provides a uniform method for comparing time varying sound levels. The L_{max} is the maximum sound level measured during a time period, and in this report refers to the L_{max} RMS 'fast' level with a 0.125 second time constant. The L_{90} is the A-weighted sound level that is exceeded for 90 percent of the time during the time period. The L_{90} can be thought of as the quietest ten percent of any time period and it generally does not include transient sound events. The L_{90} is used to determine compliance with the MADEP Noise Policy.

1.2 Regulatory Requirements

There are no local or federal noise control regulations with decibels limits that apply to the Project. The MADEP regulates sound through Regulation 310 CMR 7.10 that prohibits "unnecessary emissions" of sound. The MADEP's Policy Statement 90-001 interprets a violation of this noise regulation to have occurred if the source causes either:

[5] American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., 1989 ASHRAE Handbook, Fundamentals, (I-P) Edition, Atlanta, GA, 1989.
[6] American National Standards Institute, ANSI S12.9-1996/Part 4, "Noise Assessment and Prediction of Long-Term Community Response," New York, 1996, page 15.
[7] National Marine Fisheries Service, letter from Ms. Patricia Kurkal, Regional Administrator to Ms. Christine Godfrey, U.S. Army Corps of Engineers, June 27, 2002.
[8] Urick, R., Principles of Underwater Sound, 3rd Edition, McGraw-Hill, 1983, p. 206.

4.2 Seaward of State Territorial Limit (Beyond 3-miles)

4.2.1 Above Water Sound

4.2.1.1 Construction Effects

The sound effects of construction will be temporary and are associated with the installation of 130 16-foot diameter monopiles (one for each WTG), installation of six smaller 4-foot diameter piles for the ESP, and vessel traffic for transporting equipment, piles, and workers to the site. The jet plow embedment process for laying submarine power cables with a cable barge (see Section 4.2.3.4 of the Draft EIS) produces no sound beyond typical vessel traffic in Nantucket Sound. The principal sound from construction will therefore be temporary pile driving of the WTG monopiles using a drop hammer similar to an IHC S-600. The driving rate will be in the range of 2 to 36 impacts per minute. Sound data from installation of similar sized piles at the Utgrunden Wind Park were used in the acoustic modeling (see Section 2.3.1). Only one monopile will be driven at a time, and sound levels will depend on the distance from the receiver to the particular point in the Wind Park array and whether the receiver is upwind or downwind of the location where the monopile is being driven. (In the former case, the wind shadow effect substantially reduces sound levels).

Table 5 summarizes the predicted minimum and maximum temporary sound levels (L_{max}) at Buoys G5 and R20 (the receivers) from pile driving in the Wind Park. The minimum impacts are associated with pile driving at the WTG location farthest away from the receiver, while maximum impacts are associated with pile driving at the WTG location closest to the receiver. The predicted construction impacts are 31 dBA to 76 dBA when the receiver is downwind of the pile driving activity and 8 dBA to 49 dBA when the receiver is upwind of the activity. Existing average sound levels (L_{eq}) at sea in the vicinity of the Project are now approximately 46 to 51 dBA (see Section 3.1). These existing levels represent daytime conditions for a non-motorized vessel (e.g., a sailboat) running downwind in light wind conditions. For such boaters, the acoustic modeling results reveal that sometimes the temporary pile driving activity will be audible (i.e., above existing levels) and sometimes it will not, depending on a boater's distance from the monopile being driven and whether he is upwind or downwind of the activity. It should also be noted that occupants of sailboats tacking upwind or motorboats will experience higher baseline sound levels, and for these boaters it is less likely that temporary sound from Project construction will be audible.

4.2.1.2 Operational Effects

Acoustic modeling was performed for two wind conditions: (1) the WTG cut-in wind speed (8 mph at hub height); and (2) the WTG design wind speed (30 mph at hub height). Event (1) represents the Project operating condition when existing sound levels will be lowest, and Event (2) represents the maximum sound levels from the Project. WTG sound-source data were provided by GE Wind Energy from recent tests performed at a GE 3.6 MW unit operating near Barrax, Spain. Simultaneous operation of all 130 WTGs was assumed in the modeling.

Figures 12 and 13 present the frequency spectra of the maximum continuous sound levels from Project operation for the cut-in wind speed at Buoys G5 and R20, along with the existing baseline sound spectra. Buoys R5 and G20 are along the edges of the North Channel and Main Channel closest to the Wind Park and represent the closest likely approach by a recreational boater to the Wind Park. Existing sound levels are 46 to 51 dBA and represent daytime conditions for a non-motorized vessel (e.g., a sailboat) running downwind when the average surface wind speed is about 5 mph. (Occupants of a sailboat tacking upwind or a motorboat would experience higher baseline sound levels). For such boaters, Project operational sound levels of 30 to 34 dBA are well below existing sound levels of 46 to 51 dBA, and the spectrum formed by adding the Project to the existing baseline levels contains no pure tones in the vicinity of the 80 Hz band where the Project has an energy peak (see Table 6); therefore the Project will be inaudible. The results also reveal that low-frequency sound from the Project (< 63 Hz) is below the threshold of human hearing and would be inaudible regardless of the baseline sound levels.

Figures 14 and 15 present the frequency spectra of the maximum continuous sound levels from Project operation for the design wind speed at Buoys G5 and R20, along with the existing baseline sound spectra. Buoys R5 and G20 are along the edges of the North Channel and Main Channel closest to the Wind Park and represent the closest likely approach by a recreational boater to the Wind Park. Existing sound levels are 60 to 65 dBA and represent daytime conditions for a non-motorized vessel (e.g., a sailboat) running downwind when the average

FIGURE 13: MAXIMUM CONTINUOUS SOUND LEVEL FROM PROJECT OPERATION AT BUOY R20 FOR THE CUT-IN WIND SPEED

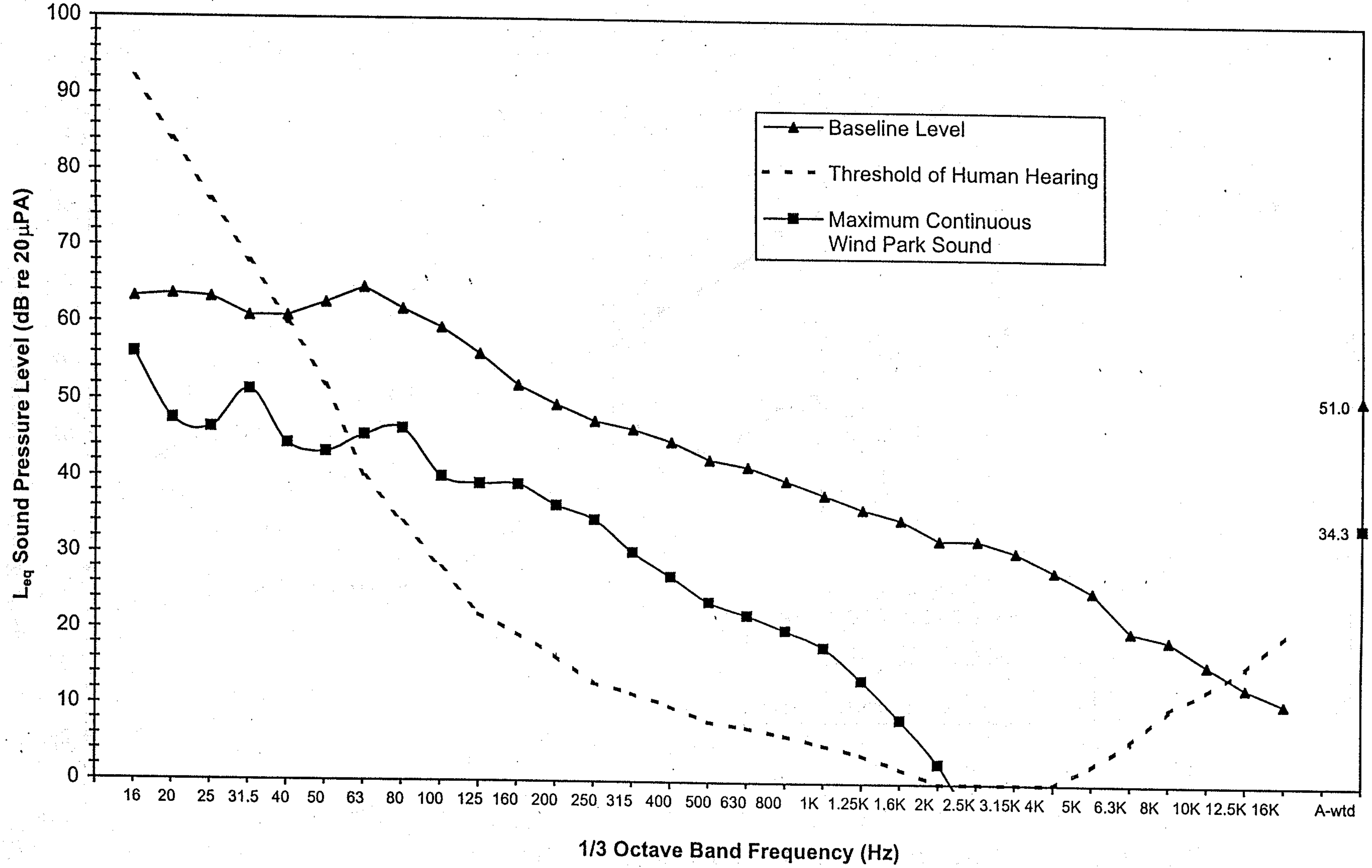

FIGURE 14: MAXIMUM CONTINUOUS SOUND LEVEL FROM PROJECT OPERATION AT BUOY G5 FOR THE DESIGN WIND SPEED