

5.700 RULE ON SOUND LEVELS FROM WIND GENERATION FACILITIES

5.701 Purpose and Applicability

This rule establishes standards and procedures related to sound emissions from wind generation facilities that apply for a certificate of public good (“CPG”) pursuant to 30 V.S.A. § 248 or § 8010 on or after July 1, 2017.

5.702 Definitions

For the purposes of this Rule, the following definitions shall apply:

Board: the Vermont Public Service Board

Contributing turbines: the turbine or group of turbines at a wind generation facility whose removal from a facility sound model results in a residual project-only predicted sound pressure level at the receptor of less than 30 dBA or a reduction in predicted turbine contribution of at least 6 dB at the point of measurement

CPG: certificate of public good

CPG Holder: a person or company who has received a CPG pursuant to 30 V.S.A. § 248 or § 8010 for a wind generation facility

dB: a unit used to measure the intensity of a sound wave using a logarithmic scale

dBA: A-weighted decibel

Department: the Vermont Department of Public Service

L_{A10}: Sound level exceeded during 10% of a measurement period

L_{A50}: Sound level exceeded during 50% of a measurement period

L_{A90}: Sound level exceeded during 90% of a measurement period

L_{eq}: Continuous sound level in dB equivalent to the total sound energy over a given period of time

NRO mode: Noise Reduced Operation mode, in which the rotational speed of wind turbines is limited in order to reduce their sound emissions

Participating landowner: a landowner who has signed a written agreement with a Petitioner stating that the sound emission and setback standards established by this rule do not apply to the landowner’s property

Petitioner: a person or company who has filed a petition for a CPG pursuant to 30 V.S.A. § 248 or 8010 to construct and/or operate a wind generation facility

Plant capacity: pursuant to 30 V.S.A. § 8002, “plant capacity” means the rated electrical nameplate for a wind generation facility

Residence: a permanent structure for human habitation that is occupied by one or more people for a minimum of 90 days each year

SCADA: supervisory control and data acquisition or similar system capable of measuring and recording turbine operation and meteorological data in one-minute time intervals

Wind generation facility: a wind-driven electric generation facility for which a petition for a CPG pursuant to 30 V.S.A. § 248 or § 8010 is submitted to the Board on or after July 1, 2017

5.703 General Rule

No wind generation facility shall emit sound levels in excess of the following during operation:

- (A) Facilities with a plant capacity up to and including 50 kilowatts. Operation of facilities with a plant capacity up to and including 50 kilowatts shall not result in: (1) sound pressure levels that exceed 42 dBA more than 5% of the time at a distance of 100 feet from the residence of a non-participating landowner; or (2) audible prominent discrete-frequency tones pursuant to the latest revision of ANSI S1.13 Annex A at a distance of 100 feet from the residence of a non-participating landowner.
- (B) Facilities with a plant capacity greater than 50 and up to and including 150 kilowatts. Operation of facilities with a plant capacity greater than 50 kilowatts and up to and including 150 kilowatts shall not result in sound pressure levels in excess of 42 dBA, including any penalty for tonality pursuant to Section 5.710, at a distance of 100 feet from the residence of a non-participating landowner.
- (C) Facilities with a plant capacity greater than 150 kilowatts. Operation of facilities with a plant capacity greater than 150 kW shall not result in sound pressure levels in excess of 42 dBA between the hours of 7 A.M. and 9 P.M. or 39 dBA between the hours of 9 P.M. and 7 A.M., including any penalty for tonality pursuant to Section 5.710, at a distance of 100 feet from the residence of a non-participating landowner. Each turbine and any sound-producing equipment located within the footprint of the turbine array shall be set back horizontally no less than ten (10) times the turbine's height, as measured from base to the tip of a blade in the upright, vertical position, from the residence of a non-participating landowner. This minimum setback requirement may be waived on a case-by-case basis for good cause shown.

5.704 Pre-Construction Sound Modeling

- (A) Facilities with a plant capacity up to and including 50 kilowatts. In lieu of submitting sound modeling pursuant to Section 5.704(B), below, petitions to construct and operate a wind generation facility with a plant capacity up to and including 50 kilowatts may instead file the following information with its petition:
1. All certification documents from the Small Wind Certification Council showing the results of acoustic sound testing;
 2. The distance to the nearest residence(s) in each cardinal direction, as well as an analysis of the expected sound pressure level at those residences calculated using spherical spreading.
- (B) Facilities with a plant capacity of more than 50 kilowatts. All petitions to construct and operate a wind generation facility with a plant capacity of more than 50 kW shall include a sound model developed for the proposed facility that reports the expected maximum project sound pressure levels, without using NRO mode, modeled out to a

distance where such levels are no greater than 30 dBA. A petitioner must submit the following information with its petition:

1. A map depicting the location of all proposed sound sources associated with the wind generation facility, property boundaries for the proposed facility, and all residences within the 30 dBA contour.
2. A description of the major sound sources, including tonal sound sources, associated with operation and maintenance of the facility. The sound model shall be based on the technical specifications of the turbine model(s) with the highest manufacturer apparent sound power level under consideration for use at the facility.
3. The results of sound modeling pursuant to ISO 9613-2, including a description of the equivalent continuous sound levels expected to be produced by the sound sources at a distance of 100 feet from the residences of non-participating landowners. The description shall include a full-page isopleths map depicting the predicted sound pressure levels expected to be produced by the wind generation facility at a distance of 100 feet from each residence of a non-participating landowner within the 30 dBA isopleth. The predictive model used to generate the equivalent sound levels expected to be produced by the sound sources shall be designed to represent the “predictable worst case scenario.” All model inputs shall be the most realistic and conservative available for each of the items listed below unless otherwise approved by the Board, and shall include, at a minimum, the following:
 - a. The maximum apparent sound power output of the sound sources pursuant to IEC 61400-11;
 - b. Modeling in accordance with ISO 9613-2, with each turbine modeled as a point source at hub height;
 - c. All turbines operating at maximum apparent sound output;
 - d. Attenuation due to air absorption, with conditions set to 10°C and 70% relative humidity;
 - e. Attenuation due to ground absorption/reflection, based on mixed ground conditions ($G=0.5$) for propagation over land and hard conditions ($G=0.0$) for propagation over water;
 - f. Attenuation due to three-dimensional terrain;
 - g. Receiver height modeled at both 1.5 and 4 meters;
 - h. Attenuation due to meteorological factors such as relative wind speed

and direction (wind rose data), temperature/vertical profiles and relative humidity, sky conditions, and atmospheric profiles;

- i. An adjustment to the maximum apparent sound power output of the turbines to account for turbine manufacturer uncertainty, determined in accordance with the most recent version of the IEC 61400-11 standard; and
 - j. A disclosure of the model's error, which is intended to account for uncertainties in the modeling of sound propagation for wind energy developments. This error shall be accounted for and incorporated as an addition to the full rated output of the sound sources.
4. A description of proposed major sound control measures, including their locations and expected acoustical performance;
 5. A comparison of the expected sound pressure levels from the proposed wind generation facility with the applicable sound pressure level limits of Section 5.703;
 6. A description and map identifying potential compliance testing locations on or near the proposed wind generation facility site. The identified compliance testing locations shall be selected to take advantage of prevailing downwind conditions and shall be able to meet the site selection criteria outlined in Section 5.707. The identified locations shall include those locations that are expected to experience the highest model-predicted equivalent sound levels. The locations shall be free from sources of material sound contamination.
 7. Prior to commencing site preparation or construction of a facility, a CPG Holder shall update, supplement, and/or amend the sound modeling to reflect any changes to the sound-producing elements of the facility. An opportunity to review and comment on any change to the sound modeling, and to request a hearing, shall be given to all parties to the 30 V.S.A. § 248 proceeding who had standing on the issue of sound. The Board may, in its discretion, grant a hearing if a party who had standing on the issue of sound demonstrates that the revised sound modeling represents a likelihood of an exceedance of the applicable sound emissions standard specified in Section 5.703. If the Board holds a hearing, the CPG Holder may not commence site preparation or construction of the facility until the Board resolves the issue.

5.705 Post-Construction Sound Monitoring Applicability

(A) Facilities with a plant capacity up to and including 50 kilowatts. Post-construction sound monitoring may be required by the Board for a facility in this category if it is determined that exceedances of the applicable sound-level limit are probable or as part of an investigation into one or more complaints.

- (B) Facilities with a plant capacity greater than 50 and up to and including 150 kilowatts. Sound monitoring shall take place in accordance with Section 5.707, below, or pursuant to an alternative monitoring plan adopted in the facility's CPG. In lieu of verifying compliance with the applicable sound-level limit through sound monitoring, a petitioner may propose to locate a wind generation facility in this category such that every sound-producing element of the facility within the turbine footprint will be set back horizontally no less than ten (10) times the turbine's height, as measured from base to the tip of a blade in the upright, vertical position, from the residence of a non-participating landowner.
- (C) Facilities with a plant capacity greater than 150 kilowatts. Sound monitoring shall take place during the times specified in section 5.711, in accordance with the requirements of this rule and any requirements of the CPG, which shall specify the minimum number of compliance monitoring locations, the radius from the nearest facility turbine in which monitoring locations may be selected, and the time period of monitoring. The monitoring will be used to verify the accuracy of the pre-construction modeling and facility compliance with CPG conditions and the requirements of this rule. In addition to the requirements of this rule and the CPG, the Board may, at its discretion, require additional monitoring if the results of the initial post-construction sound monitoring or changes to the facility or its operation indicate that exceedances of the sound-level limit are probable.

5.706 Post-Construction Sound Monitoring General Requirements

- (A) Monitoring by the State. Post-construction sound monitoring shall be conducted under the direct supervision and control of a State of Vermont agency or agencies designated by the Board. The post-construction sound monitoring shall be paid for by the CPG Holder.
- (B) Monitoring locations. A petition for a CPG for a wind generation facility shall include proposed monitoring locations for post-construction monitoring. The proposed locations shall include residential locations that are expected to experience the highest model-predicted equivalent sound levels and are consistent with the requirements of Section 5.707. The proposed locations shall be free from sources of material sound contamination. Any change in monitoring locations must be approved in advance by the Board.
- (C) Modification of pre-construction sound modeling. A CPG Holder is required to identify the appropriate inputs and/or assumptions, and modify the pre-construction sound modeling if the post-construction sound monitoring indicates that there is a reasonable likelihood that the expected highest sound levels at any of the monitoring locations would be equal to or greater than 3 dBA above those modeled, or would result in an exceedance of the sound level standard specified in Section 5.703. All parties to the 30 V.S.A. § 248 or § 8010 proceeding in which a CPG was granted who had standing on the issue of sound shall be given an opportunity to review and comment on any change to the sound modeling. The Board may, in its discretion, grant a hearing if a party who had standing on the issue of sound demonstrates that

the revised sound modeling indicates a likelihood of an exceedance of the applicable sound emissions standard specified in Section 5.703.

5.707 Post-Construction Sound Monitoring Methodology

- (A) Measurement personnel. Measurements shall be supervised by personnel who are well qualified by training and experience in measurement and evaluation of environmental sound. Certification through the Institute of Noise Control Engineering shall meet the qualification requirements of this section.
- (B) Measurement instrumentation. The sound meter or alternative sound measurement system used shall meet all appropriate industry standards and specifications. Each monitoring site shall include installation of an anemometer and other equipment or sensors capable of gathering and recording weather conditions at the microphone (10-meter-level wind speed, wind direction, temperature, humidity, and precipitation) and be equipped with enhanced-performance windscreens capable of significantly reducing or eliminating wind-induced noise contamination over the microphone. The measurement instrumentation shall meet the following specifications unless otherwise approved by the Board:
1. The sound level meter or alternative sound level measurement system shall meet the Type 1 performance requirements of American National Standard Specifications for Sound Level Meters, ANSI S1.4.
 2. The integrating sound level meter (or measurement system) shall also meet the Type 1 performance requirements for integrating/averaging in the International Electrotechnical Commission Standard on Integrating-Averaging Sound Level Meters, IEC Publication 61672-1.
 3. The filter for determining the existence of tonal sounds shall meet all the requirements of the American National Standard Specification for Octave-Band and Fractional Octave-Band Analog and Digital Filters, ANSI S1.11 and IEC 61260, Type 3-D performance.
 4. The acoustical calibrator shall be of a type recommended by the manufacturer of the sound level meter and one that meets the requirements of American National Standard Specification for Acoustical Calibrators, ANSI S1.40.
 5. Anemometer(s) for surface (10 meter (m)) (32.8 feet) wind speeds shall have a minimum manufacturer specified accuracy of ± 1 mph providing data in 10-second integrations and 10-minute average/maximum values for the evaluation of atmospheric stability.
 6. Audio recording devices shall be time stamped (hh:mm:ss), recording the sound signal output from the measurement microphone to be used for identifying events. Audio recording and compliance data collection shall be measured through the same microphone/sound meter and bear the same time

stamp.

(C) Equipment calibration.

1. The sound level meter shall have been calibrated to the manufacturer's specification no more than 24 months prior to completion of a measurement campaign, and the microphone's response shall be traceable to the National Institute of Standards and Technology.
2. Field calibrations shall be recorded and documented in compliance monitoring reports.
3. The 10-meter anemometer(s) and vane(s) shall have been calibrated to the manufacturer's specification no more than 24 months prior to completion of a measurement campaign.

(D) Compliance measurement location, configuration, and environment.

1. Compliance measurement locations shall be approved by the Board during its review of a facility's request for a CPG and shall be representative of the non-participating residences expected to experience the highest model-predicted facility-only sound levels from routine operation of the wind generation facility, subject to permission from the respective property owner(s). Measurement locations shall reasonably be expected to experience downwind conditions from acoustically significant turbines and shall be free from significant sources of sound contamination, such as high-traffic roadways, industrial or silvicultural activity, etc.
 - a. To the greatest extent possible, compliance measurement locations shall be at the center of unobstructed areas that are maintained free of vegetation and other structures or material that is greater than 2 feet in height for a 75-foot radius around the sound and audio monitoring equipment.
 - b. To the greatest extent possible, meteorological measurement locations shall be at the center of open flat terrain, inclusive of grass and minimum number of obstacles that are greater than 6 feet in height for a 250-foot radius around the anemometer location. Meteorological measurements shall be taken at the monitoring location at or above the height of the audio/acoustic microphone.
 - c. Meteorological measurements of wind speed and direction shall be collected using anemometers at a 10-meter height (32.8 feet) above the ground. Results shall be reported, based on 10-second integration intervals, synchronously with turbine nacelle measurements and measurements made at the sound-meter level at one-minute measurement intervals. The wind speed average and maximum for each one-minute interval shall be reported.

- d. The sound microphone shall be positioned at a height of approximately 1.5 meters above the ground, and oriented in accordance with the manufacturer's recommendations.
- e. When possible, measurement locations should be at least 50 feet from any sound source. The proposed locations shall be free from sources of material sound contamination. Any non-facility sources of sound shall be noted in the analysis.

5.708 Determination of Background/Ambient Sound Levels

In order to determine the ambient sound levels at a receptor, turbine shutdowns will be required as part of post-construction sound monitoring. A CPG Holder shall conduct turbine shutdowns in accordance with the requirements of its CPG. The CPG shall specify the minimum number and duration of turbine shutdowns during the post-construction sound monitoring. The timing of turbine shutdowns shall be determined by the State of Vermont agency overseeing post-construction sound monitoring in consultation with the project operator. In the event that turbine shutdowns are technically infeasible, background sound levels may be determined using a primary and shielded secondary sound level meter.

5.709 Post-construction Sound Monitoring Specific Measurements

The following data shall be measured and recorded in one-minute increments:

(A) Acoustic parameters:

1. Overall L_{Aeq} (20-20,000 Hz);
2. Unweighted $1/3^{rd}$ octave spectra (20-20,000 Hz);
3. Narrowband spectra (20-4,000 Hz, 1-Hz resolution, hanning window).

(B) Meteorological data. All meteorological data as specified in Section 5.712 shall be measured and recorded synchronously with the acoustic parameters listed in Section 5.709(A)1, above.

(C) Turbine operational data including power output, rotor rotational speed, and the meteorological data listed in Section 5.707.

5.710 Post-Construction Sound Monitoring Data Analysis

(A) All recorded data shall be categorized as "Turbine On" or "Ambient," or shall be excluded.

1. Turbine On data shall meet the following criteria:

- a. All Contributing Turbines for a specific receptor shall be operational. The minimum power output for each Contributing Turbine shall be specified in the project's CPG.

- b. The monitoring location receptor shall be within 45° of the direction between a specific measurement location and the acoustic center of the five nearest wind turbines, or fewer if the wind generation facility does not have five wind turbines.
 2. Ambient data shall be categorized as such only when all Contributing Turbines are shut down or generating less than 1% of nameplate capacity.
 3. Data meeting any of the following criteria shall be excluded from analysis:
 - a. Data that cannot be categorized as Turbine On or Ambient;
 - b. Periods between 10 minutes prior to and one hour after precipitation at the monitoring location is detected;
 - c. Intervals contaminated by transient ambient sound sources, such as passing cars, barking dogs, etc.;
 - d. Periods when 10-meter wind speed is greater than 5 meters per second.
- (B) Additional frequency-based filtering of the data may be performed if unique conditions at the monitoring location(s) justify such action. In such an instance, the designated individual, agency, or company responsible for sound monitoring data analysis shall notify the Board of the intent to apply additional filtering to an identified set of data and the basis for such action. An opportunity to review and comment on any proposed additional filtering shall be given to all parties to the 30 V.S.A. § 248 or § 8010 proceeding in which a CPG was granted who had standing on the issue of sound prior to the commencement of any additional filtering.
- (C) Filtered sound monitoring data shall be analyzed consistent with the following protocols.
 1. Overall sound levels shall be derived using the following methodology:
 - a. Filtered one-minute L_{Aeq} sound levels shall be separated into Turbine On and Ambient datasets.
 - b. Turbine On and Ambient datasets shall be sorted into one-meter-per-second integer wind bins based on the measured average wind speed for each interval at the monitoring location.
 - c. Mean average Turbine On and Ambient sound level shall be computed in each wind bin.
 - d. The average Ambient sound level shall be logarithmically subtracted

from the average Turbine On sound level in each wind bin to derive the project-only sound level.

- e. Wind bin averages shall not be reported if the difference between the Turbine On average sound level and Ambient sound level in a wind bin is less than 3 dBA.
2. Sound monitoring data analysis shall be based on a minimum of 120 filtered one-minute L_{Aeq} data points. In the event that 20 valid data points in each of the six wind bins are not available, wind bin averages may be reported when there are a minimum of 40 one-minute L_{Aeq} sound levels in at least three wind bins. If sufficient valid data are not obtained after ten (10) weeks of monitoring, the State of Vermont agency designated by the Board shall provide a status update and recommendation for any additional monitoring to the Board.
 3. Tonality shall be determined and applied to the overall sound level using the following methodology.
 - a. Filtered narrowband spectra shall be separated into Turbine On and Ambient datasets.
 - b. Turbine On and Ambient datasets shall be sorted into one-meter-per-second integer wind bins based on the measured average wind speed for each interval at the monitoring location.
 - c. The overall average tonal audibility for each wind bin shall be calculated pursuant to the methodology contained in IEC 61400-11 or the latest revision of the same.
 - d. If tonal audibility in any wind bin is greater than 2 dB, a penalty to the project-only sound level in that wind bin shall be applied pursuant to ISO 1996-2, Figure C.1 or the latest revision of the same.

5.711 Compliance Data Collection, Measurement, and Retention Procedures

(A) All operational, sound, audio, and meteorological data collected shall be retained by the State of Vermont agency or agencies designated by the Board for the life of the project and subject to inspection upon request.

(B) Monitoring and data collection shall occur at a minimum:

1. Once during the first year of facility operation, including sound power testing pursuant to IEC 61400-11 for each turbine;
2. Once during each successive fifth year thereafter until the facility is decommissioned; and

3. In response to a complaint if ordered by the Board. The Board in its discretion may require additional sound monitoring or sound power testing for a wind generation facility in response to a complaint if the Board determines that a complaint raises a reasonable possibility that a wind generation facility is operating in excess of the sound level limits required by this rule. In making its determination, the Board shall consider:
 - a. The details of the complaint;
 - b. Any response thereto filed by the operator of the wind generation facility; and
 - c. Any response and recommendation by the Department of Public Service after its review of the complaint, the facility operator's response, and any attempts made to resolve the complaint under the complaint response procedure(s) issued by the Vermont Department of Public Service pursuant to Section 5c of Public Act 130 (2016 Vt., Adj. Sess.). As part of any recommendation, the Department may propose a plan for additional sound monitoring or sound power testing of the subject wind generation facility. Any such proposal should incorporate the requirements and standards set forth in subsection (b), below, or set forth an explanation why different requirements and standards are being proposed.

(C) All relevant turbine operational data (SCADA); the date, time, and duration of any NRO or other operational changes that occur during the sound monitoring period; and sound level and meteorological data collected during a compliance measurement period that meets or exceeds the specified wind speed parameters shall be submitted by the State of Vermont agency or agencies designated by the Board to the Board for review and approval. All data shall be submitted to the Board within 60 days of completion of the monitoring period as part of the post-monitoring report. Audio recordings will only be submitted upon request and may be filtered to exclude private conversations and/or submitted under a confidentiality order.

5.712 Reporting of Compliance Measurement Data Compliance reports shall be submitted to the Board within 60 days of the completion of the sound monitoring period. The Board will make the report publicly available. The report shall include a certification that the required monitoring conditions were present and, at a minimum, the following:

- (A) A narrative description of the sound from the wind generation facility for the compliance measurement period;
- (B) The dates, days of the week, and hours of the day when measurements were made;
- (C) The wind direction and speed, temperature, humidity, and sky condition;

- (D) Identification of all measurement equipment by make, model, and serial number;
- (E) All meteorological, sound, windscreen, and audio instrumentation specifications and calibrations;
- (F) All A-weighted equivalent sound levels for each 1-minute measurement interval;
- (G) Short-period sound level measurements (50 milliseconds or less);
- (H) All L_{A10} , L_{A50} , and L_{A90} percentile levels;
- (I) All 1-minute 1/3 octave band unweighted and equivalent continuous sound levels (dB);
- (J) Should any sound data collection be observed by a trained attendant, a summary of the attendant's notes and observations;
- (K) All concurrent time-stamped, turbine-operational data including the date, time, and duration of any noise-reduction operation or other interruptions in operations, if present; and
- (L) All other information determined necessary by the Board.

5.713 Complaint Response Procedures

CPG Holders shall respond to complaints raised by residents located near the wind generation facility in a manner consistent with the complaint response procedure(s) issued by the Vermont Department of Public Service pursuant to Section 5c of Public Act 130 (2016 Vt., Adj. Sess.)