

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:

- (A) **Board**: the Vermont Public Service Board.
- (B) **CPG**: certificate of public good.
- (C) **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.
- (D) **dB**: a unit used to measure the intensity of a sound wave using a logarithmic scale.
- (E) **dB_A**: A-weighted decibel
- (F) **Department**: the Vermont Department of Public Service.
- (G) **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.
- (H) **Plant capacity**: pursuant to 30 V.S.A. § 8002, “plant capacity” means the rated electrical nameplate for a wind generation facility.
- (I) **Residence**: a permanent structure for human habitation that is occupied by one or more people for a minimum of 90 days each year.
- (J) **SCADA**: supervisory control and data acquisition or similar system capable of measuring and recording turbine operation and meteorological data in one-minute time intervals.
- (K) **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.
- (L) **L_{eq}**: Continuous sound level in dB equivalent to the total sound energy over a given period of time.
- (M) **L_{A90}**: Sound level exceeded during 90% of a measurement period.
- (N) **L_{A10}**: Sound level exceeded during 10% of a measurement period.
- (O) **L_{A50}**: Sound level exceeded during 50% of a measurement period.
- (P) **Participating landowner**: a landowner who has signed a written agreement with a Petitioner stating that the sound emissions standards established by this rule do not apply to the landowner’s property.
- (Q) **NRO mode**: Noise Reduced Operation mode, in which the rotational speed of wind turbines is limited in order to reduce their sound emissions.

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 of 150 kilowatts or less. Operation of facilities with a plant capacity of 150 kilowatts (“kW”) or less shall not result in: (1) audible prominent discrete-frequency tones pursuant to the latest revision of ANSI S1.13 Annex A at a distance of 100 feet from the residences of non-participating landowners; and (2) sound pressure levels in excess of 42 dBA between the hours of 7 A.M. and 9 P.M. and 35 dBA between the hours of 9 P.M. and 7 A.M. at a distance of 100 feet from the residences of non-participating landowners. In lieu of demonstrating compliance with this limit, a petitioner may propose to locate a wind generation facility such that every sound-producing element of the facility 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 residences of non-participating landowners.
- (B) Facilities with a plant capacity of greater than 150 kW. Operation of facilities with a plant capacity of greater than 150 kW shall not result in: (1) audible prominent discrete-frequency tones pursuant to the latest revision of ANSI S1.13 Annex A at a distance of 100 feet from the residences of non-participating landowners; and (2) sound pressure levels in excess of 42 dBA between the hours of 7 A.M. and 9 P.M. and 35 dBA between the hours of 9 P.M. and 7 A.M. at a distance of 100 feet from the residences of non-participating landowners. Each sound-producing element of such facilities shall be set back horizontally no less than ten (10) times the turbines’ height, as measured from base to the tip of a blade in the upright, vertical position, from the residences of non-participating landowners.

5.704 Compliance with the Sound Level Limits

Compliance with the sound level limits shall be determined in accordance with the following:

- (A) Sound level data shall be aggregated in 10-minute measurement intervals within a given compliance measurement period under the conditions set forth in Section 5.707 of this rule. Each hour of the compliance measurement period shall have six discrete 10-minute measurement intervals.
- (B) Compliance will be demonstrated when the arithmetic average of the equivalent sound level of, at a minimum, twelve 10-minute measurement intervals in a given compliance measurement period is less than or equal to the sound level limit set forth in Section 5.703. The loudest valid 10-minute measurement intervals shall be included in the calculation of the arithmetic average.
- (C) If a given compliance measurement period does not produce a minimum of twelve 10-minute measurement intervals under the atmospheric and site conditions set forth in Section 5.708(E) of this rule, six or more 10-minute measurement intervals from one compliance measurement period may be combined with six or more 10-minute intervals from other compliance measurement periods (e.g., other days). Compliance will be demonstrated when the arithmetic average of the combined 10-minute measurement intervals is less than or equal to the applicable equivalent sound level

limit set forth in Section 5.703. The loudest valid 10-minute measurement intervals shall be included in the calculation of the arithmetic average.

5.705 Pre-Construction Sound Modeling

All petitions to construct and operate a wind generation facility, except for those for a wind generation facility with a capacity of 50 kW or less, shall include a sound model developed for the proposed facility that reports the expected maximum project sound levels, without using NRO mode, experienced out to a distance where such levels are no greater than 30 dBA. A petitioner must submit the following information with its petition:

- (A) 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.
- (B) 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.
- (C) 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:
 - (1) The maximum apparent sound power output (IEC 61400-11) of the sound sources;
 - (2) Modeling in accordance with ISO 9613-2, with each turbine modeled as a point source at hub height;
 - (3) All turbines operating at full rated sound output;
 - (4) Attenuation due to air absorption, with conditions set to 10°C and 70% relative humidity;
 - (5) 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;
 - (6) Attenuation due to three-dimensional terrain;
 - (7) A receiver height of four (4) meters;
 - (8) 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;

- (9) An adjustment to the maximum rated output of the turbines to account for turbine manufacturer uncertainty, determined in accordance with the most recent version of the IEC 61400 Part 11 standard; and
- (10) 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 maximum rated output of the sound sources.
- (D) A description of proposed major sound control measures, including their locations and expected acoustical performance;
- (E) 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.
- (F) A description and map identifying 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(D). The identified locations should include those locations that are expected to experience the highest model-predicted equivalent sound levels. The locations should be free from sources of material sound contamination.
- (G) Prior to commencing site preparation or construction of the 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 have standing on the issue of sound. The Board may, in its discretion, grant a hearing if a party who has 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.

5.706 Post-Construction Sound Monitoring

Sound monitoring shall take place during the times specified in section 5.708(D), 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, at its discretion, the Board may 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 likely.

- (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(D). The proposed locations should 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 who have 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 has 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 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, 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. A sound level meter or alternative sound level measurement system used shall meet the Type 1 performance requirements of American National Standard Specifications for Sound Level Meters, ANSI S1.4.
2. An 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. A 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 used 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) used 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 equivalent sound levels from routine operation of the wind generation facility, subject to permission from the respective property owner(s).

- 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 10-minute measurement intervals. The wind speed average and maximum for each 10-minute interval shall be reported.
 - d. The sound microphone shall be positioned at a height of approximately 4 to 5 feet 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 should be free from sources of material sound contamination. Any non-facility sources of sound shall be noted in the analysis.
4. The CPG Holder shall provide all relevant turbine operational data for the monitoring period, including SCADA data for all turbines, the date, time, and duration of any noise reduction operation or other operational changes that occur during the compliance measurement period.

5.708 Compliance Data Collection, Measurement, and Retention Procedures

(A) Measurements of operational, sound, audio, and meteorological data shall occur as set forth in Section 5.707.

(B) 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.

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

1. Once during each of the first four years of facility operation, provided, however,

that if after three years the monitoring does not detect and the updated sound model does not predict any exceedances of the applicable equivalent sound pressure level in Section 5.703, the fourth year of monitoring and data collection under this subsection shall not be required;

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.
 - a. The Board in its discretion may require sound monitoring 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:
 - i. The details of the complaint;
 - ii. Any response thereto filed by the operator of the wind generation facility; and
 - iii. 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 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.
 - b. Any monitoring ordered by the Board pursuant to this subsection:
 - i. Shall conform to the meteorological requirements set forth in Section 5.708(E) of this rule, if possible.
 - ii. Shall be done under meteorological conditions as similar as possible to the conditions existing at the time of the complaint.
 - iii. In the event that the monitoring cannot be performed pursuant to the meteorological requirements set forth in Section 5.708(E) of this rule due to prevailing meteorological or environmental conditions at the time the complaint is filed and when the monitoring will take place, then the Department of Public Service may propose a plan of sound monitoring for review and approval by the Board. Any such proposed monitoring plan should:
 1. Require that sound monitoring be performed under meteorological conditions similar to those that existed at the time the complaint was made;
 2. Provide for sound monitoring compliance testing consistent with the requirements of Section 5.704 of this rule with

- monitoring continuing until the requisite number of measurement intervals are collected.
- iv. The sound monitoring methodology for any such proposal shall be consistent with the requirements of Section 5.707 of this rule.
 - v. Microphones shall be placed in locations that avoid material sound contamination. All microphone locations must be approved by the Board.
 - vi. Primary microphones shall not be placed such that any structure blocks the line of sight between the microphone and the facility's turbines (if otherwise visible).
 - vii. Provide a process for determination of facility-only sound. In the event the determination of facility-only sound will rely on subtracting background sound levels from overall sound levels (i.e. sound levels with the facility's turbines in operation), such background sound levels shall be determined by measurements taken with the facility's wind turbines shut down for a period of at least 30 minutes both before and after sound monitoring is performed to determine total sound levels with the facility in operation.
 - viii. The monitoring shall be performed with at least 90% of the facility's turbines operating at maximum sound power levels. Monitoring shall continue until the requisite amount of data is collected under these operating conditions.
 - ix. Measurement intervals affected by increased biological activities, leaf rustling, traffic, high water flow, aircraft flyovers, or other extraneous ambient noise sources that affect the ability to demonstrate compliance shall be excluded from all compliance report data.
 - x. Reporting of the results of the monitoring shall be done consistent with the requirements of section 5.709 of this rule.

(D) All operational (SCADA), 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.

(E) Measurements shall be obtained during weather conditions when the wind turbine sound is dominant and overall sound levels are not influenced by non-facility sounds. Such conditions are generally expected at night, when the measurement location is downwind of the wind generation facility and maximum surface wind speeds (10-meter height) are equal to or less than 6 miles per hour (mph) with concurrent turbine hub-elevation wind speeds sufficient to generate the highest continuous apparent

sound power, +/- 1 dB, from the nearest wind turbines to the measurement location. A downwind location is defined as 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. In some circumstances, it may not be feasible to meet the wind speed and operations criteria due to terrain features or limited elevation change between the wind turbines and monitoring locations. In these cases, measurement periods are acceptable if the following conditions are met:

1. The difference between the L_{A90} and L_{A10} during any 10-minute period is less than 5 dBA; and
2. The surface wind speed (10-meter height) (32.8 feet) is 6 mph or less for 80% of the 10-minute measurement period and does not exceed 10 mph at any time, or the turbines are shut down during the monitoring period and the difference in the observed L_{A50} after shutdown is equal to or greater than 6 dBA; and
3. Observer logs or recorded sound files clearly indicate the dominance of wind turbine(s).
4. Measurement intervals affected by increased biological activities, leaf rustling, traffic, high water flow, aircraft flyovers, or other extraneous ambient noise sources that affect the ability to demonstrate compliance shall be excluded from all compliance report data. The intent is to obtain 10-minute measurement intervals that entirely meet the specific criteria and represent facility-only sound pressure levels.

5.709 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 10-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 10-minute 1/3 octave band unweighted and equivalent continuous sound levels (dB);
- (J) Should any sound data collection be observed by a trained attendant, the attendant's notes and observations shall be summarized and included with the Compliance Report;
- (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.

5.710 Complaint Response Procedures

Complaints raised by residents located near the wind generation facility shall be responded to 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.)