Guidance for Large Wind Energy Conversion System Noise Study Protocol and Report

Guidance for Developing and e-Filing the LWECS Noise Study Protocol and Report Submittals to the Minnesota Public Utilities Commission

COMMERCE DEPARTMENT
DIVISION OF ENERGY RESOURCES

Energy Environmental Review and Analysis

Acknowledgments

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Purpose

The purpose of this guidance document is to help wind developers prepare and use a project-specific noise study protocol to guide post-construction noise monitoring, data analysis and reporting according to standard methodologies. Pre-construction modeling recommendations are available in the Department of Commerce's "Application Guidance for Site Permitting of Large Wind Energy Conversion Systems in Minnesota".

The purpose of the protocol and the resulting noise study report are to quantify total post-construction sound and assess Large Wind Energy Conversion System (LWECS) contribution at receptors in the project area. The monitoring, analysis, and report will provide information to:

- determine total noise levels and LWECS contribution at different frequen-cies and at various distances from the turbines at various wind directions and speeds;
- assess probable compliance with Minnesota noise standards;
- confirm the validity of the noise modeling conducted prior to permit issuance or prior to construction; and
- assess the modeling as a predictor of probable compliance with Minnesota noise standards.

This document describes the general parameters for monitoring and reporting post construction noise. It also provides general guidance for developing the noise study protocol document and the report. The actual monitoring, protocol and report for a specific project will likely include more detail and shall address project-specific consider-ations.

Noise study protocols and reports are reviewed by Department of Commerce, Energy Environmental Review and analysis (EERA) staff, and staff comments and recommen-dations are provided to the Minnesota Public Utilities Commission (Commission). EERA staff may recommend and the Commission may require changes to a noise study protocol. However, consultation with the EERA staff state permit manager for the project during preparation of the noise study protocol and report is recommend-ed to minimize the need for changes after filing.

Monitoring and Reporting Guidelines

Scope

Noise standards under Minnesota Rule 7030 are total noise standards. Therefore, noise monitoring must address total post-project sound levels in the project area as well as turbine contribution to total sound. This can be accomplished in a couple of ways. First, through an “on/off” monitoring campaign that collects total sound data in the project area with all turbines operating as well as total sound data in the project area without turbines operating, and uses information from these two datasets to deduce turbine contribution. Second, this can be accomplished through a monitoring campaign that collects total sound data in the project area with all turbines operating and also collects total sound data offsite in an area that is similar

to the project area, but unaffected by turbine sound, comparing the two datasets and evaluating sound data characteristics to assess turbine contribution. Permittees should consult with the EERA staff state permit manager as they determine which approach to use and both the protocol and final report should document the rationale for the method chosen.

Specifically, the scope of the monitoring must address:

1. **Total Sound:** Monitor total noise levels at receptors in the project area during operation, with all project turbines operating.

AND

2. **LWECS Turbine Contribution to Total Sound:** Monitor total noise levels in the absence of LWECS operational noise. Use these noise monitoring results, along with the measure of total noise during tur-bine operation collected in **1** to assess turbine contribution to total sound. Choose one of the following methods:

2a. Monitoring Within the Project, Same Locations, Turbines Off. In conjunction with the monitoring in **1**. and using the same methods and the same monitoring locations within the project site, monitor sound with all of this project's turbines in place but not operating. OR

2b. Monitoring Off-Site, Same Timeframe. Concurrently with the monitoring in **1.**, conduct off-site monitoring to contribute additional data that supports evaluation of sound that exists in analogous environments in the absence of wind turbines. For comparability, noise monitoring methodology for off-site monitor-ing must be the same as for the monitoring in **1**.

Monitoring Methodology

Monitoring Locations

- The protocol must include a clear rationale of the selection of the locations where sound will be monitored. The rationale should identify the features that each location was selected to represent and address its distance to receptors and to nearby turbines or other sources of sound.
- Monitoring should be conducted at a minimum of three representative lo-cations within the project area that are in proximity to a receptor, such as a residence. Discuss the monitoring locations with the EERA staff state permit manager as early in the planning process as possible.
- One monitoring location must be in proximity to the worst- case receptor pre-dicted by the model.
- Do not choose monitoring locations that are in areas that reflect or absorb sound or where there are obstructions to sound.
- For off-site monitoring that is done under 2b., the rationale for the selection of off-site monitoring locations should address factors that were considered in determin-ing that the environment at the location(s) is(are) analogous to the locations within the project site.

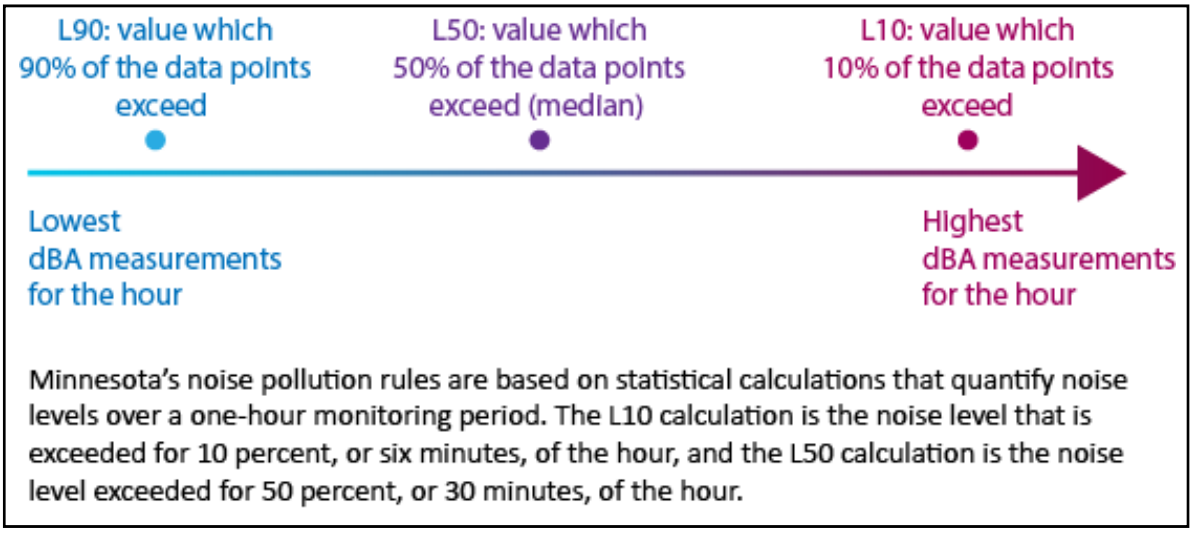
Monitoring Timing and Duration

- The choice of season and factors that were considered in determining the timing of monitoring should be explained in the protocol.
- At each location, monitoring must adequately capture sound levels for hub-height wind speeds above the identified cut-in wind speed for the turbine model. If adequate data is not captured during the initial planned duration for monitoring, the monitoring duration should be extended.
- At each location, monitoring must adequately capture sound levels for microphone-height wind speeds below the identified level at which distortion may compromise the data (11 miles per hour) If adequate data is not captured during the initial planned duration for monitoring, the monitoring duration should be extended.
- Include in the protocol an explanation of the criteria that will be used to deter-mine if the monitoring timeframe will be extended; for example, if insufficient data of a certain type is not obtained.
- For monitoring described in 1. and 2b., collect sound measurements continuously over a minimum of a 7 to 14 day period. Data will be evaluated in 1 hour increments (see below).
- For monitoring described in 2a., collect sound measurements over a sufficient period of time to ensure that valid comparisons can be made between “off” and “on” measurements. This will likely require 3 or more targeted nights of monitoring to adequately characterize sound levels over the relevant range of hub height windspeeds.

Monitored Data

- Sound pressure level, audio recordings, and meteorological data should be collected at each monitoring location.
- Sound level data must be collected to provide a quantitative indication of noise at the microphone and allow comparison to numerical standards. Sound level data should include time-synchronized one-third octave band levels at 1- second intervals to allow characterization of different sound sources as well as identification of short-term activities for potential filtering from the dataset (e.g. mowing, heavy equipment).
- Audio recordings should be automatically collected when noise levels were unusually high. Collecting audio during such times makes it possible to go back and listen to anomalous noise events and determine the potential cause(s) of elevated sound levels.
- Determine unweighted sound; A-weighted dBA as L10, L50, L90 and Leq on an hourly basis; and C-weighted L10, L50, L90 and Leq on an hourly basis. Each one hour period must begin at the start of the hour in the recorded time of day. In the protocol and final report these terms should be defined as indicated in Figure 1 to avoid confusion.

Figure 1. Statistical calculations to quantify noise over one-hour periods



- Determine unweighted, A-weighted and C-weighted one-third octave- band analysis for at least as low as 16 (preferably lower), 20, 25, 31.5, 40, 50, 63, 80, 100, 125, 160, 200, 250, 315, 400, 500, 630, 800, 1K, 1.25K, 1.6 K, 2K, 2.5K, 3.15 K, 4K, 5 K, 6.3 K, and 8K HZ or higher for a representative wind speed for the location that is in proximity to the worst-case receptor predicted by the model and for the off-site location (if applicable).
- Meteorological data should be collected at sound level meter height and should include wind speed, and precipitation. This data should be used to identify periods during which weather conditions (precipitation, high winds on the microphone) distort and invalidate sound level measurements.
- Hub-height meteorological data from one or more met towers within the project area must be obtained for the same time periods and time intervals as the monitoring and should include wind speed and direction. This data should be used to confirm that adequate sound level monitoring data is captured across the relevant range of hub height wind speeds.

Monitoring Equipment

- Use a sound level meter and a microphone conforming to type 0, 1, 2 or S specifications under ANSI S1.4-1983, a calibrator of known frequency and level, and an oversized microphone wind screen.
- Calibration must be done before and after the monitoring period. Sound measurements must be taken at least 3 feet above the ground.
- An anemometer or similar instrumentation to determine wind speed at microphone height must be used.

Monitoring Analysis and Reporting

Data processing

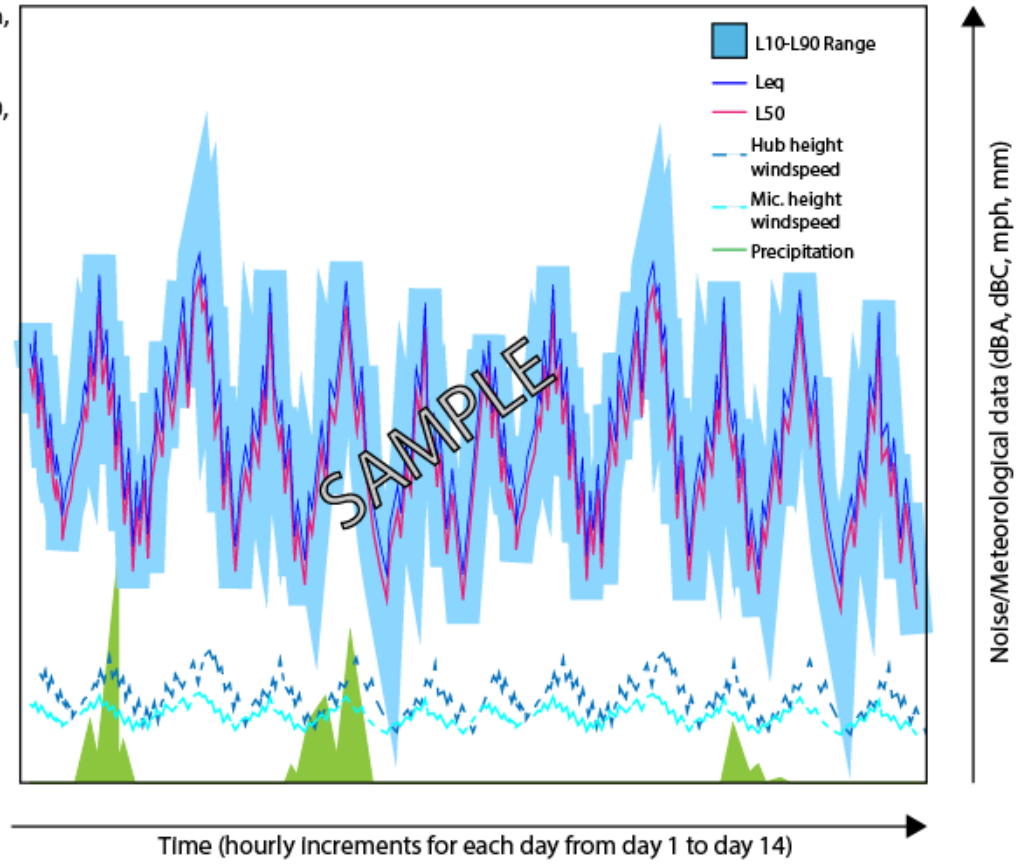
- "Spikes" of sporadic noise, such as a motorized vehicle going by, a clap of thunder, or a dog barking, may be eliminated from the data, as long as an explanation is included in the report for the types of sound and percentage of measurements for each that were eliminated, for each location and for each monitoring event. Similarly, data collected during documented periods of precipitation may also be eliminated from the data, as long as an explanation is provided in the report and the percentage of mea-surements that were eliminated, for each location and for each monitoring event, is reported.
- For each hour, for all the sound mea-surements obtained during that hour, determine the L10, L50, L90, and Leq as dBA and the L10, L50, L90 and Leq as dBC. Do not include the sound measure-ments that are being eliminated with explanation as allowed above.

Data Reporting

- **Map Location of Monitoring Points.** Provide a map showing an aerial photo-graphic layer with the location of turbines, monitoring locations, residences and location of significant local noise sources such as concentrations of agricul-tural activity (for example, a feedlot) or human activity (for example, traffic). The scale of the map should show the distance between monitoring points and the distance of the monitoring point to the nearest turbine.
- **Results at Varying Wind Speeds.** Report continuous sound measurements at all wind speeds that occur during the monitoring. Present a time series of the total Leq, L90, L50 and L10 for dBA and Leq, L90, L50 and L10 for dBC sound levels for each hour (Figure 2). Chart a similar time series (combine them onto one chart with the sound levels) for corresponding hub-height and microphone height wind speed in miles per hour and precipitation in mm. If the number of parameters presented on the chart is crowded, separate charts may be done for the sound level parameters if preferred but wind speed and precipitation should always be shown along with a measure of sound level.

Figure 2. Presentation of Results for all data for monitoring

For each montitoring location, create a time series chart for each monitoring event.
Chart data points for Leq, L90, L50 and L10 for each hour in dBA and also in dBC.
On the same chart create a time series for wind speed at hub height and microphone height and for precipitation.



- **Results at Varying Frequencies.** Present one-third octave-band analysis (at least as low as 16 and preferably lower, 20, 25, 31.5, 40, 50, 63, 80, 100, 125, 160, 200, 250, 315, 400, 500, 630, 800, 1K, 1.25K, 1.6 K, 2K, 2.5K, 3.15 K, 4K, 5 K, 6.3 K, and 8K HZ or higher) for each monitoring location. Do not include the sound measurements that were excluded as part of the data processing step described above.
- **Results for Turbine Contribution.**
  1. Use monitoring results from 2a to assess turbine on, turbine off, and turbine only sound levels for each monitoring location. Present these results in charts and tables as appropriate.
  2. Use monitoring results from 2b to assess sound measurements over the range of frequencies with turbines operating to the sound measurements at the offsite monitor and present estimated turbine only L10 and L50 levels for each monitoring location. Present these results in charts and tables as appropriate.
- **Comparison to Minnesota Noise Standards**. Compare total and turbine only sound levels to the daytime and nighttime Minnesota noise standards. Include in the report a summary of the L10 and L50 hourly determi-nations for total sound that are above the Minnesota noise standards for each monitoring location and discuss turbine to these total noise levels exceedanc-es.

- **Results of Noise Modeling.**
  1. Present a map of the modeling that was done previously for the project. Modeling contours must be represented on the map as lines, or transparent shading, at 5 db increments. Show the contours for modeling provided with the permit application, adjusted for the final turbine layout prior to construction. Explain what the contours represent precisely.
2. For modeled sound predicted during the permitting process or prior to construction, include in the report an explanation of the methodology, the assumptions in the chosen model and a narrative description of the choices made for criteria in using the model.
3. Include a narrative conclusion regarding how well the monitored results compare to the predicted sound levels for the project and how well the modeling performed as a predictor of probable compliance with the Minnesota noise standards. If the results do not compare favorably, explain.

Protocol and Report Development Guidelines

Noise Study Protocol Document

Protocol Contents

The noise study protocol for the monitoring should address following elements, consistent with the monitoring and reporting guidelines in this document:

- the purpose of the monitoring;
- the monitoring scope;
- the monitoring locations and their rationale;
- the monitoring timing and duration;
- the monitored data
- the monitoring the equipment;
- data processing;
- data reporting;

Preparation/Efiling

After the Noise Study Protocol has been prepared according to this guidance, complete a compliance filing on the Minnesota Public Utilities Commission (Commission) and Department of Commerce E-Dockets system, by the date specified in the Commission LWECS site permit for the project, at this web address: https://www.edockets.state.mn.us/EFiling/.

Address the cover letter to the Executive Secretary of the Minnesota Public Utilities Commission for the submittal and for any subsequent revisions.

Daniel Wolf, Executive Secretary

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121 Seventh Place East Saint Paul, MN 55101

Noise Study Report Document

Report Contents

In the noise study report, describe the actual conditions, measurement locations, instrumentation, procedures, methodology, data obtained and results, including charts, and conclusions consistent with the monitoring and reporting guidelines in this document and the noise study protocol approved by the Commission. Document any changes from the approved protocol with an explanation as to the necessity, and any impact the changes may have on interpretation of results.

Prepara ion/Efiling

E-file the noise study report for the completed monitoring and a cover letter summarizing the results and conclusions. Attach the previously e-filed protocol for the monitoring to the noise study report. Indicate in the report any approvals of the protocol by the Minnesota Public Utilities Commission and how and when the approvals were obtained.

Address the cover letter to the Executive Secretary of the Minnesota Public Utilities Commission for the submittal and for any subsequent revisions.

Daniel P. Wolf, Executive Secretary

Minnesota Public Utilities Commission 350 Metro Square Building

121 Seventh Place East Saint Paul, MN 55101

References

1. American Wind Energy Association and Canadian Wind Energy Association, Wind Turbine Sound and Health Effects, An Expert Panel Review, December 2009.
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5. National Association of Regulatory Utility Commissioners, Assessing Sound Emissions from Proposed Wind Farms and Measuring the Performance of Completed Projects, October 2011.
6. Wisconsin Public Service Commission, Measurement Protocol for Sound and Vibration Assessment of Proposed and Existing Wind Electric Generation, adopted May 26, 2010.