

# MEASUREMENT PROTOCOL FOR SOUND AND VIBRATION ASSESSMENT OF PROPOSED AND EXISTING WIND ELECTRIC GENERATION PLANTS

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July, 2014

**Note: Consult with Commission staff prior to conducting any sound and vibration measurements.**

## I. Objectives

The primary objectives of this protocol include:

1. To measure and characterize the existing sound and vibration environment in the area of the proposed development.
2. To predict the incremental increase in sound and vibration levels that would occur as a result of operation of the proposed development.
3. To verify that the predicted incremental increase in sound and vibration levels is reasonable by taking post-construction sound level measurements.
4. To verify compliance with applicable sound and vibration level limitations by taking post-construction sound level measurements.

## II. PSC Staff Contacts

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## III. Introduction

The potential sound and vibration impact associated with the operation of wind electric generation developments is often a primary concern for citizens living in the areas of the developments. This is especially true of projects located near homes, residential neighborhoods, schools, and hospitals (sensitive receptors). Determining the likely sound and vibration impacts is a highly technical undertaking and requires a serious effort in order to collect reliable and meaningful data for both the public and decision-makers.

This protocol is based, in part, on criteria published in the Standard Guide for Selection of Environmental Noise Measurements and Criteria.<sup>1</sup> The purpose of this protocol is to establish a consistent and scientifically sound procedure for estimating existing sound and vibration levels in a project area.

The layout of the proposed development and the features of the surrounding environment will influence the design of the sound and vibration study. Site layout and the existence of significant local sound and vibration sources and sensitive receptors must be taken into consideration when designing a sound and vibration study. It may be necessary to hire a qualified consultant to conduct the sound and vibration study.

**Note: Consult with Commission staff prior to conducting any sound and vibration measurements.**

These guidelines are meant to be general in nature and may need to be modified to reflect unique site characteristics or use of curtailment as a noise mitigation strategy. **Consult with Commission staff assigned to the project for guidance on study design before you begin any pre- or post-construction sound and vibration study.** During consultation, good quality maps and diagrams of the site will be necessary. Maps and diagrams should show the site layout on an aerial photograph base and identify important landscape features as well as significant local sound and vibration sources and sensitive receptors.

#### **IV. Measurement of the Existing Sound and Vibration Environment**

An estimate of the project area's existing sound and vibration environment is necessary in order to predict the likely impact resulting from a proposed project. The following guidelines must be used in developing a reasonable estimate of an area's existing sound and vibration environment.

##### **A. Sites With No Existing Generation**

1. At a minimum, sound level measurements should be taken at three locations or measurement points (MPs). Because each site is unique, more than three MPs may be necessary. **Consult with Commission staff regarding the quantity and location of the MPs.**

MPs selected in consultation with Commission staff will generally be selected to provide information on the range of noise environments in a wind project area. Some examples of areas commonly selected for measurements include: areas with residences, areas with industrial noises, quiet areas, and public areas.

2. Duration of measurements should be a minimum of ten continuous minutes for each criterion (See item 4 below) at each location. Measurements should be taken during each of the following four periods:
  - a. Morning (6 - 8 a.m.)
  - b. Midday (12 noon – 2 p.m.)
  - c. Evening (6 - 8 p.m.)
  - d. Night (10 p.m. – 12 midnight)

The use of unattended continuous sound level measurement devices is encouraged. If these measurements are collected, qualitative sound recordings of the ambient noise environment should be collected for the duration of the measurements.

Sound level measurements must be made on a weekday of a non-holiday week.

3. For each MP and for each measurement period, provide each of the following measurement criteria:
  - a. At a minimum, unweighted octave-band analysis (16,<sup>ii</sup> 31.5, 63, 125, 250, 500, 1K, 2K, 4K, & 8K Hz), one-third octave band analysis is encouraged
  - b.  $L_{ave}$ ,  $L_{10}$ ,  $L_{50}$ , and  $L_{90}$ , in dBA
  - c.  $L_{ave}$ ,  $L_{10}$ ,  $L_{50}$ , and  $L_{90}$ , in dBC
  - d. A narrative description of sounds audible during each measurement
4. Identify all major sources of sound and vibration (i.e. highways, factories etc.) and where they are located in relation to MPs.
5. Provide a map on an aerial photo base clearly showing:
  - a. the layout of the site
  - b. the location of MPs
  - c. the distance between MPs and the nearest proposed wind turbine generators
  - d. the location of significant local sound and vibration sources
  - e. the distance between all MPs and significant local sound and vibration sources
  - f. the location of all sensitive receptors (schools, day-care centers, hospitals, and residences or residential neighborhoods) within the project area
  - g. the distance to all major infrastructure (major roads, transmission lines, gas pipelines) in project area

## **B. Sites With Existing Wind Electric Generation Facilities**

1. Two complete sets of sound level measurements must be taken under two wind conditions:
  - a. Under calm conditions without the existing wind turbine rotors rotating. These measurements shall be taken with the entire wind generating development off line.
  - b. Under wind conditions just above the cut-in speed for the wind turbines with as many of the wind turbines in the development operating as possible.

For measurements taken with the turbines operating, the turbines must be operated in normal mode, and may not be operated in any noise reduction modes.

2. At a minimum, sound level measurements should be taken at three MPs. Because each site is unique, more than three MPs may be necessary. **Consult with Commission staff regarding the quantity and location of the MPs.**

MPs selected in consultation with Commission staff will generally be selected to provide information on the range of noise environments in a wind project area. Some examples of areas commonly selected for measurements include: areas with residences, areas with industrial noises, quiet areas, and public areas.

All MPs should be located so that no significant obstruction (building etc.) blocks sound and vibration from existing wind facilities.

3. Duration of measurements should be a minimum of ten continuous minutes for each criterion (see section IV.B.4 below) at each location. Measurements should be taken during each of the following four periods:

- a. Morning (6 - 8 a.m.)
- b. Midday (12 noon – 2 p.m.)
- c. Evening (6 - 8 p.m.)
- d. Night (10 p.m. – 12 midnight)

The use of unattended continuous sound level measurement devices is encouraged. If these measurements are collected, qualitative sound recordings of the ambient noise environment should be collected for the duration of the measurements.

Sound level measurements must be taken on a weekday of a non-holiday week.

4. For each MP and for each measurement period, provide each of the following measurement criteria:
  - a. At a minimum, unweighted octave-band analysis (16,<sup>ii</sup> 31.5, 63, 125, 250, 500, 1K, 2K, 4K, & 8K Hz), one-third octave band analysis is encouraged
  - b.  $L_{ave}$ ,  $L_{10}$ ,  $L_{50}$ , and  $L_{90}$ , in dBA
  - c.  $L_{ave}$ ,  $L_{10}$ ,  $L_{50}$ , and  $L_{90}$ , in dBC
  - d. A narrative description of sounds audible during each measurement
5. Identify all major sources of sound and vibration (e.g. highways, factories etc.) and where they are located in relation to each MP.
6. Provide a map or diagram clearly showing:
  - a. the layout of the site
  - b. the location of MPs
  - c. the distance between MPs and the nearest existing wind turbine generators
  - d. the location of significant local sound and vibration sources
  - e. the distance between all MPs and significant local sound and vibration sources
  - f. the location of all sensitive receptors (schools, day-care centers, hospitals, and residences or residential neighborhoods) within the project area
  - g. the distance to all major infrastructure (major roads, transmission lines, gas pipelines) in project area

### **C. Sound Level Estimates for Proposed Wind Turbine(s)**

In order to estimate the sound and vibration impact of the proposed wind development on the existing environment, an estimate of the sound and vibration produced by the proposed turbine(s) must be provided.

1. Provide the manufacturer's sound level characteristics for the proposed turbine model operating at full capacity. Include an **unweighted** octave band (16,<sup>ii</sup> 31.5, 63, 125, 250, 500, 1K, 2K, 4K, & 8K Hz) analysis for the unit at full capacity.
2. Provide contour maps of the expected sound levels from the wind energy development, in 5 dBA increments, extending out to the 30 dBA contour. Provide sound level modeling showing predicted sound levels from the proposed facilities using ground absorption coefficients of both 0.0 and 0.5.
3. Determine the impact of the new sound and vibration source on the existing environment. For each MP used in the ambient study:

- a. Report expected changes to existing sound levels for  $L_{ave}$ ,  $L_{10}$ ,  $L_{50}$ , and  $L_{90}$ , in dBA.
- b. Report expected changes to existing sound levels for  $L_{ave}$ ,  $L_{10}$ ,  $L_{50}$ , and  $L_{90}$ , in dBC.

At least one MP should be located at the nearest sensitive receptors, as required by sections IV.A.1 and IV.B.2.

4. Clearly report all assumptions made in arriving at the estimates of impact and any conclusions reached regarding the potential effects on people living in the project area.

## **V. Post-Construction Measurements**

1. Within twelve months of the date when the project is fully operational, and within two weeks of the anniversary date of the pre-construction ambient noise measurements, repeat the existing sound and vibration environment measurements taken before project approval.
2. Post-construction sound level measurements should be taken under two wind conditions:
  - a. Under calm conditions without the wind turbine rotors rotating. These measurements shall be taken with the entire wind generating development off line.
  - b. Under wind conditions just above the cut-in speed for the wind turbines with as many of the wind turbines in the development operating as possible.

For measurements taken with the turbines operating, the turbines must be operated in normal mode, and may not be operated in any noise reduction modes.

3. Notes regarding post-construction sound level measurements for wind project developments:
  - a. Measurements taken as required under section V.2.b may be taken prior to measurements taken under section V.2.a.
  - b. Because of the variability of wind speeds, post-construction measurements may be taken outside of the measurement periods listed in section IV.B.3. However, measurements taken under section V.2.a, above, must be taken during the same time of day as the corresponding measurements taken under section V.2.b.
  - c. For each MP at which pre-construction noise measurements were taken, a minimum of three sets of measurements shall be taken under sections V.2.a and 2.b. The three sets of measurements should correspond to at least two different times of day. Any or all of the measurements may be taken outside of the measurement periods listed in section IV.B.3.
  - d. Measurements taken to fulfill the requirements of items sections V.2.a and 2.b must be taken within as few consecutive days as practicable.
  - e. Measurements taken under sections V.2.a and 2.b must include a measurement of the 16 Hz octave band, as described in section IV.B.4.a.
4. The post-construction sound level measurement analysis must include an evaluation of whether the wind development meets any and all state and local sound level requirements.

5. File a copy of the post-construction noise measurement report with the Public Service Commission including pre- and post-construction measurement data and using the same report format as used for the pre-construction sound and vibration study reports.

## Revision History

### Revisions of May 26, 2010:

- Adapted the November 17, 2008, version of the PSC Noise Protocol to apply specifically to wind energy developments.

### Revisions of July 22, 2014:

- Section II, updated staff contact information.
- Sections IV.B.1 and V.2, clarified that turbines ON measurements be taken with the turbines operating in normal mode, and not in any noise reduction modes.
- Section IV.C.2, added requirement to provide sound level contour maps using ground absorption coefficients of both 0.0 and 0.5.

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<sup>i</sup> Standard Guide for Selection of Environmental Noise Measurements and Criteria (Designation E 1686-96). July 1996. American Society for Testing and Measurements.

<sup>ii</sup> PSC staff acknowledges that few sound level meters are capable of measurement of the 16 Hz center frequency octave band. However, because noise complaints from the public most likely involve low frequency noise associated with proposed plants, we encourage applicants to pursue the collection of this important ambient noise data.

**If obtaining the 16 Hz data is beyond the capabilities of the sound level measurement apparatus, contact PSC staff prior to collection of any field ambient measurement data.**