

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

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November 2008

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

## I. Introduction

The potential sound and vibration impact associated with the operation of electric generators is often a primary concern for citizens living near proposed power plant sites. This is especially true of projects located near homes, residential neighborhoods, schools, and hospitals. 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 first establish a consistent and scientifically sound procedure for estimating existing sound and vibration levels in a project area, and second, to determine the likely impact that operation of a new electric power plant will have on the existing sound and vibration environment.

The characteristics of your proposed power plant project and the features of the surrounding environment will influence the design of the sound and vibration study. Site layout, types of generation, and the existence of significant local sound and vibration sources and sensitive receptors should be taken into consideration when designing a sound and vibration study. It may be advisable 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 accommodate unique site characteristics. Consult with Commission staff assigned to the project for guidance on study design before you begin the sound and vibration study. During consultation, good quality maps or diagrams of the site will be necessary. Maps and diagrams should show the site layout and identify important landscape features as well as significant local sound and vibration sources and sensitive receptors.**

## II. 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 Existing Generation (See Figure 1)

1. Two complete sets of sound level measurements must be taken:
  - a. One complete set of measurements with the generator(s) off.
  - b. One complete set of measurements with existing generator(s) running at full capacity.

If the site includes an existing baseload generator, it is acceptable to take one existing sound level measurement with the baseload unit running and any existing peaking units off and another measurement with all units on.

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

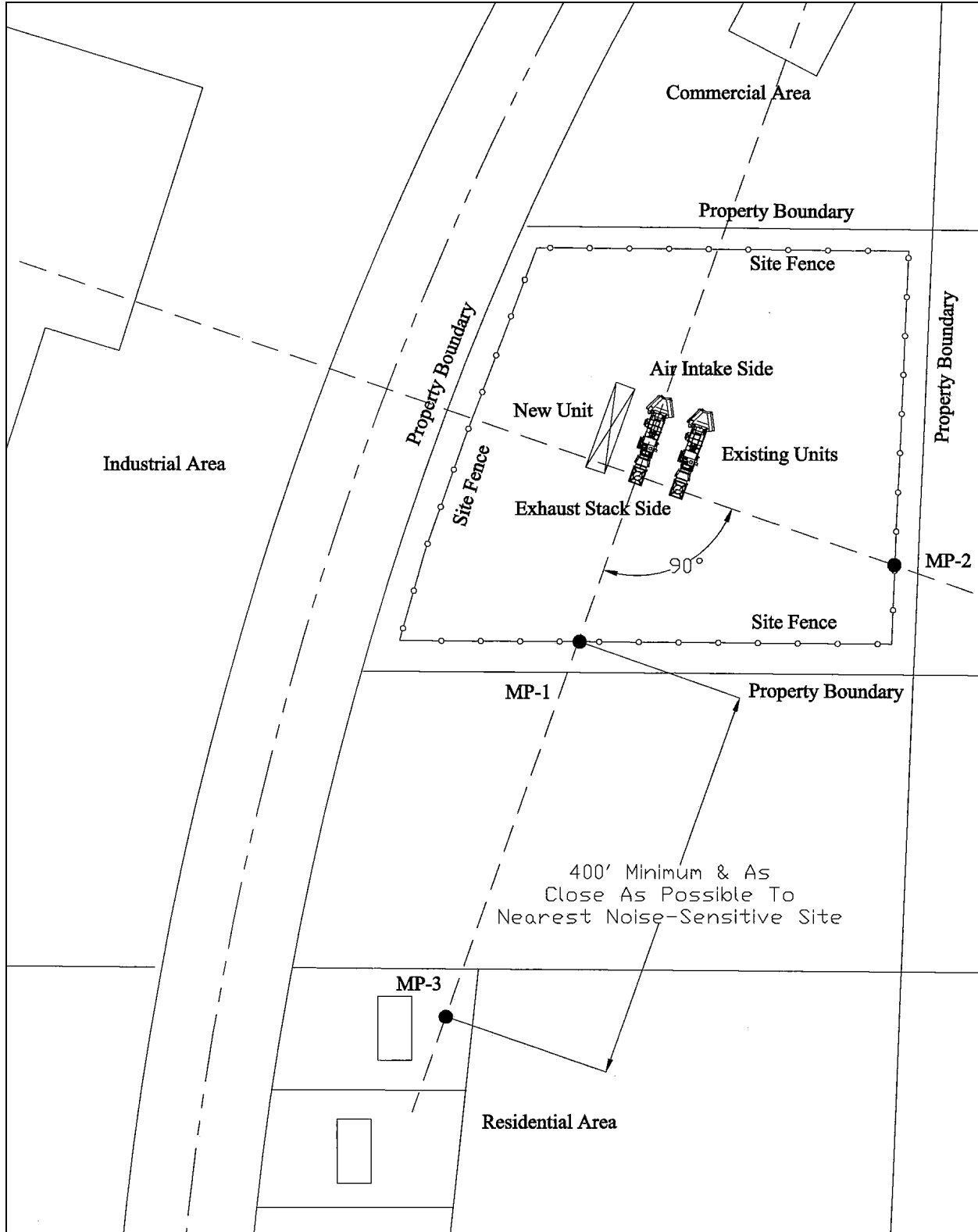
Two sets of measurements should be taken at the site's fence. If the project site is to be expanded in order to accommodate the new generator(s) then the location of the new site fence should be taken into consideration when designing the sound and vibration assessment.

As shown in Figure 1, for sites with gas turbines, MPs should generally be located as follows:

- a. MP1 should be established at the site fence, inline with the gas turbine(s). Try to locate MP1 closest to the exhaust stack(s) and closest to the most frequently used generator. If the existing generation is not a combustion turbine then MP1 should be located at the site fence nearest the principal sound and vibration source.
- b. MP2 should also be located along the site fence. Locate MP2 at a point 90 degrees, with respect to the existing generators, from MP1. If possible locate MP2 where the ambient sound level is likely to be the least.
- c. MP3 should be located 400 feet from MP1 and on a line extending through the existing turbines and MP1. MP3 must be located away from as many ambient sound and vibration sources as possible.
- d. Additional MPs should be located as close as possible to the nearest sensitive receptors.

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

**Figure 1 – Recommended Sound Level Measurement Points**



3. 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)

Sound level measurements must be made 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. Unweighted octave-band analysis (16,<sup>2</sup> 31.5, 63, 125, 250, 500, 1K, 2K, 4K, & 8K Hz)
- 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

Required sound level measurement criteria is summarized in Table 1.

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 MP1 and MP2 and existing 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 400 feet of the site
- g. the distance to all major infrastructure (major roads, transmission lines, gas pipelines) within 400 feet of the project site.

## **B. Sites with No Existing Generation**

1. At a minimum, sound level measurements should be taken at three measurement points (MPs). See Figure 1. Because each site is unique, more than three MPs may be necessary.

**Consult with Commission staff regarding the quantity and location of the MPs.**

Determine the location of the sites' fenced perimeter. If the approximate location of the proposed generator(s) is known, locate MPs as described for sites with existing generation (See item 2, section titled Sites With Existing Generation). If the location of the new generator(s) is

not known, then determine the most likely location. Locate MPs based on the assumed location of the proposed generator(s).

2. Duration of measurements should be a minimum of ten continuous minutes for each criterion (See item 3 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)

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. Unweighted octave-band analysis (16, <sup>2</sup>31.5, 63, 125, 250, 500, 1K, 2K, 4K, & 8K Hz)
- 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

Required sound level measurement criteria is summarized in Table 1.

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 or diagram clearly showing:

- a. the layout of the site
- b. the location of MPs
- c. the distance between MP1 and MP2 and existing 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 400 feet of the site
- g. the distance to all major infrastructure (major roads, transmission lines, gas pipelines) within 400 feet of the project site.

**Table 1 – Required Sound Level Measurement Criteria**

	Existing Ambient Noise	Existing Noise With Existing Unit(s) Running	Projected Noise Levels With Existing And New Unit(s) Running	Post-Construction Actual Noise Levels
<b>A- Weighted Sound Level (dBA)</b>	Lave, L10, L50, L90 Measured At MP-1, MP-2, & MP-3 Measured during each period, 6-8am Noon-2pm, 6-8pm, and 10pm-Midnight	Lave, L10, L50, L90 Measured At MP-1, MP-2, & MP-3 Measured during each period, 6-8am Noon-2pm, 6-8pm, and 10pm-Midnight	Lavg calculated at Site Fence, 100', 400', and 1000' (CT) and 1500', 2000', and 3000' (CC) of Site Fence	Lave, L10, L50, L90 Measured At MP-1, MP-2, & MP-3 Measured during each period, 6-8am Noon-2pm, 6-8pm, and 10pm-Midnight
<b>C- Weighted Sound Level (dBC)</b>	Lave, L10, L50, L90 Measured At MP-1, MP-2, & MP-3 Measured during each period, 6-8am Noon-2pm, 6-8pm, and 10pm-Midnight	Lave, L10, L50, L90 Measured At MP-1, MP-2, & MP-3 Measured during each period, 6-8am Noon-2pm, 6-8pm, and 10pm-Midnight	Lavg calculated at Site Fence, 100', 400', and 1000' (CT) and 1500', 2000', and 3000' (CC) of Site Fence	Lave, L10, L50, L90 Measured At MP-1, MP-2, & MP-3 Measured during each period, 6-8am Noon-2pm, 6-8pm, and 10pm-Midnight
<b>Octave Bands (dB) 16, 2, 31.5, 63, 125, 250, 500, 1K, 2K, 4K and 8K Hz</b>	Sound Level, L Measured At MP-1, MP-2, & MP-3 Measured during each period, 6-8am Noon-2pm, 6-8pm, and 10pm-Midnight	Sound Level, L Measured At MP-1, MP-2, & MP-3 Measured during each period, 6-8am Noon-2pm, 6-8pm, and 10pm-Midnight	Sound Level, L, calculated at Site Fence, 100', 400', and 1000' (CT) and 1500', 2000', and 3000' (CC) of Site Fence	Sound Level, L Measured At MP-1, MP-2, & MP-3 Measured during each period, 6-8am Noon-2pm, 6-8pm, and 10pm-Midnight

## C. Sound Level Estimate for Proposed Generator(s)

In order to estimate the sound and vibration impact of the proposed project on the existing environment, an estimate of the sound and vibration produced by the proposed generator/s must be provided.

1. Provide the manufacturer's sound level characteristics for the proposed unit(s) operating at full load. Include an **unweighted** octave band (16, <sup>2</sup>31.5, 63, 125, 250, 500, 1K, 2K, 4K, & 8K Hz) analysis for the unit at full operation. If the plant consists of only combustion turbines, octave band estimates should be for distances of 100 and 400 and 1,000 feet from the generators. If the plant is a combined cycle facility, the estimates should be made for distances of 100, 400, 1000, 1500, 2000, and 3000 feet from the cooling towers, or from whichever source is expected to produce the greatest sound levels.
2. Estimate sound levels from the proposed facility in dBA and dBC at 100 feet and at 400 feet from the unit/s if the plant consists only of combustion turbines. For combined cycle plants, estimate sound levels at 100, 400, 1000, 1500, 2000, and 3000 feet from the cooling towers or whichever source produces the greatest sound levels. For projects with multiple generators the combined sound level impact for all units operating at full load must be estimated.
3. Provide a contour map of the expected sound levels from the new plant, using 5dBA increments, created by the proposed generator/s extending out to a distance of 1,000 feet for a combustion turbine plant and 3,000 feet for a combined cycle plant.
4. Determine the impact of the new sound and vibration source on the existing environment. For each measurement point 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 two measurement points must be located at the nearest sensitive receptors, as required by sections II.A.2 and II.B.1.

5. Clearly report all assumptions made in arriving at the estimates of impact and any conclusions reached regarding the potential effects on people living near the project area.
6. Include an estimate of the number of hours of operation expected from the proposed generator(s) and under what conditions generators would be expected to run. Indicate whether the plant will be used for peak, intermediate, or base load operation.

### III. 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.

For conventional generation projects, post-construction sound level measurements should be taken both with all units running at full capacity and with all units off.

For wind project developments, 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 practicable.

Notes regarding post-construction sound level measurements for wind project developments:

- i. Measurements taken as required under item b may be taken prior to measurements taken under item a.
- ii. Because of the variability of wind speeds, post-construction measurements may be taken outside of the measurement periods listed in Section IIA, item 3. However, measurements taken under item a, above, must be taken during the same time of day as the corresponding measurements taken under item b.
- iii. For each measurement point at which pre-construction noise measurements were taken, a minimum of three sets of measurements shall be taken under items a and 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 IIA, item 3.
- iv. Measurements taken to fulfill the requirements of items a and b must be taken within as few consecutive days as practicable.
- v. Measurements taken under items a and b must include a measurement of the 16 Hz octave band, as described in Section II, item B3a.

2. Report post construction measurements to the Public Service Commission using the same format as used for the pre-approval sound and vibration studies.

## Revision History

Revisions added February 7, 2002.

- Revision History section added.
- In Table 1, typographical error corrected in fourth column, “200” changed to “2000.”
- Footnotes converted to endnotes.
- In section II.C.1, added “16” to list of octave bands.
- Added endnote regarding the 16 Hz center frequency octave band measurements in every place where that measurement is mentioned.
- Changed section II.C.4 to require predictions of changes to noise levels at the measurement points from the ambient noise study. The previous language required predictions at points that did not correspond with the ambient measurement points.
- Added language in section III.1, requiring that the post-construction noise measurements take place within twelve months of initial operation, and within two weeks of the anniversary date of the pre-construction ambient noise measurements. The purpose of the change is to minimize fluctuations in seasonal ambient noise between the pre- and post construction measurements.

Revisions added November 17, 2008.

- Added instructions for post-construction noise measurements for wind developments in section III.1.

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<sup>1</sup> Standard Guide for Selection of Environmental Noise Measurements and Criteria (Designation E 1686-96). July 1996. American Society for Testing and Measurements.

<sup>2</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 presents a problem, contact PSC staff prior to collection of any field ambient measurement data.**