# M E M O R A N D U M

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To: WNTAG

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**Subject: Sound Level Sampling for MassDEP Compliance**

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## Introduction

In applying state regulation 310 CMR 7.10 to asses compliance, MAssDEP demands that the noise descriptors L90 be used to measure ambient, and Lmax to measure the increase above ambient.

The current methodology that relies on finding exact instances of violations to prove compliance under all possible circumstances is highly subjective, requires an exhaustive number of samples, and may take years to reach a conclusion. The methodology below is designed to use a small number of samples that can be used in a protocol to derive ambient (L90) and Impact (Lmax ) sound pressure levels . To capture the full effect of Amplitude Modulation, the FAST meter setting shall be used along with a sampling rate of at least 8 samples per second. The objective is to derive these parameters, in a short period of time, with assurance that they apply to large segments of time in all seasons, under weather conditions deemed to be worst case for compliance.

## Methodology

Testing will be conducted without any prior notice to the owners, or their agents of the subject wind turbines.

### Ambient

The objective is to determine the absolute minimum L90 that can be present over significant periods of time. Samples will be collected at sites based on filed complaints between the hours of midnight and 4:00 AM. No samples will be collected in the presence of precipitation (rain or snow). Wind conditions will be below cut-in speed of the nearest wind turbine. Microphones will be placed to avoid sound

pickup from sources in close proximity such as insects, outdoor compressors, etc… A number of readings can be taken, and the lowest reading will be selected as the reading to be used in assessing compliance.

### Impact

The objective is to determine the absolute maximum sound pressure level increase due to the nearest wind turbine. Impact readings shall be taken without notice to the owners or their agents, at any time during the 24 hour day. Steps may be needed to avoid extraneous transient sound instances that are clearly louder than the wind turbine sound under consideration. Any existing steady state sound level above L90 is acceptable as the existing sound level that is increased by the turbine sound. A number of samples may be collected. Samples with overwhelming transient sound levels, such as thunder, firecracker, passing airplanes, etc.. can be eliminated from consideration. From the remaining set, the highest Lmax reading will be selected for use in assessing compliance. Receptor sites must capture data from both downwind and crosswind conditions.

## Assessment

If no violations are found, the site can be declared in compliance.

Should any violations be found the site shall be declared out of compliance between 7:00 PM and 7:00 AM.

Nighttime compliance violations shall automatically require daytime testing. For day time testing, the same methodology can be applied with measuring samples collected between the hours of 10:00 AM to noon, or between 2:00 to 4:00 PM.

# Observations

## Wind Shear

The concept that ambient sound pressure level increases proportionately with increasing hub level wind speed must be abandoned. Wind shear weather conditions, where hub level wind speed is high enough to generate maximum sound power while at ground level the wind is light to calm, can occur over a significant number of times per year, and over significant periods lasting hours to days.

A report from a study done in 2002 by NREL to determine the effect of uneven blade loading as a result of wind shear, shows that the incidence and duration of extreme wind shear events occur more often than previously assumed. At the time, wind turbines were less than a megawatt and 40 meters high. Looking ahead, the report states that for megawatt plus wind turbines, wind shear coefficients will be 1 or higher, yielding a ratio of hub height wind speed to ground level of 8 to 1

For an 80 meter hub height wind turbine, the maximum sound power level wind speed of 10 m/s will only yield 1.25 m/s wind at a ground level 10 meter height. While there will be times when the increase wind speed will generate ambient sound sufficient to mask wind turbine noise, there will be a significant number of instances when wind shear high enough to avoid any masking will be experienced with time durations that can be measured in hours if not days. The report also cites evidence that high shear coefficients coincide with the higher hub level wind speeds.

Reference:

May 2002 • NREL/CP-500-32492

http://www.nrel.gov/docs/fy02osti/32492.pdf

**Evaluation of Wind Shear Patterns at Midwest Wind Energy Facilities**

Excerpt:

**Conclusion** Prolonged periods of high wind shear, particularly when combined with frequent extreme shear events (i.e., shear exponents greater than 1), are of concern from a turbine design and project development standpoint. However, since high shear frequently implies high wind speeds at turbine hub heights, harnessing this high shear offers an opportunity to increase energy production (thereby lowering the cost of energy) provided that the turbines can successfully withstand long-term operations in such

conditions. The nocturnal wind shear conditions that are present across the Midwest provide nighttime wind speeds that are greater than previously assumed. Increasing hub heights can provide access to these strong night winds. However, turbine designs need to take into account that conditions currently assumed to be extreme, rare events may actually be normal occurrences.

## Indoor/Outdoor

Some outdoor sound measurements do not affect the difference between ambient and impact sound. Outdoor sound sources in close proximity to the microphone such, as rustling leaves, whistling trees, crickets, outdoor compressors, etc… are diminished indoors by the sound barrier properties of walls, and the relative distance from the source which can be four to ten times or more. The wind turbine sound, which originates some 400 meters or more away, is only affected by the barrier properties of the walls. The increased distance indoors is insignificant in reducing the sound pressure level. As a result poor microphone placement can have an unrealistic increase in ambient sound pressure level measurements

To protect the public, all steps necessary should be taken to avoid ambient level increases coming from sound sources in proximity of the microphone.