Winter Island Wind Turbine Noise Background Study

Salem, Massachusetts

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Prepared for:

Meridian Associates

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Executive Summary

Howard Quin Consulting (HQ) and Cavanaugh Tocci Associates. (C-T) have completed a noise measurement study for a proposed 1.5 MW wind turbine installation at Winter Island in Salem, MA. In this report, HQ reviews applicable noise standards and criteria, presents the data collection program associated with the ambient noise environment, and compares the measured results to modeled results to estimate if the turbine will be in compliance.

Based on this study, we conclude the following:

- The Project location has moderate sound levels during the day and night from the nearby Salem power station, wind noise, surf noise, human activity at Winter Island, and traffic in Salem.
- The Massachusetts Department of Environmental Protection (DEP) noise guideline of 10 dB(A) increases in noise levels will not be exceeded by the proposed 1.5 MW wind turbine operation at noise-sensitive area under the conditions measured, and should probably comply under all other conditions as well.

1 Introduction

Howard Quin Consulting and Cavanaugh Tocci Associates. (C-T) were contracted by Meridian Associates to perform a noise background measurement study for a proposed wind turbine installation. The project site lies on Winter Island in Salem, MA The wind turbine would provide the town of Salem, MA with clean renewable energy to support the electricity needs of the college. The potential turbine on site would be a 1.5 MW turbine, which was examined in an earlier sound modeling study, already sent to Meridian under separate cover

Background sound was measured over a period of slightly less than three days in this study. The Leq and L90 levels were measured during early summer. Appendix A provides a description of the various noise metrics used in this report.

2 Noise Standards and Criteria

Applicable noise standards for the proposed wind turbine are the Massachusetts Department of Environmental Protection (DEP) noise guidelines. The Code of Massachusetts Regulations (Title 310, Section 7.10, amended September 1, 1972) empowers the Division of Air Quality Control (DAQC) of the Department of Environmental Protection (DEP) to enforce its noise standards. According to DAQC Policy 90-001 (February 1, 1990), a source of sound will be considered to be violating the Department's noise regulation if the source (1) increases the broadband sound level by more than 10 dBA above ambient, or (2) produces a "pure tone condition," when any octave-band center frequency sound pressure level exceeds the two adjacent frequency sound pressure levels by 3 decibels or more. Ambient is defined as the background A-weighted sound level that is exceeded 90 percent of the time (i.e. L90) measured during equipment operating hours. A wind turbine only operates when there is sufficient wind speed to run it, which is generally 4 meters per second (m/s) (9 mph) measured at a height of 10 meters (m). Note that at this location, background will also vary according to wind direction; winds from the west will raise the background sound level from the power plant. It is therefore important to consider this as well in any impact evaluation.

3 Existing Ambient Noise Environment

3.1 Measurement Program

Noise measurements of existing conditions in the project study area were conducted by C-T. A total of two long term noise measurement sites were chosen, for a measurement duration of three days. Noise measurements were conducted with RION NL-32 sound level meters/noise analyzers owned by C-T. Field calibrations with acoustic calibrators were conducted for all of the measurements. All instrumentation components, including microphones, preamplifiers and field calibrators have current laboratory certified calibrations traceable to the National Institute of Standards and Technology.

Noise measurement sites focused on residential areas, which would potentially have the most significant noise impacts from wind turbine operation. **Error! Reference source not found.** shows the locations of each of the noise measurement sites on an aerial photograph of the study area. Measurement locations were near the closest residential properties to the proposed turbine location on Winter Island Road and near the Plummer School.

The noise measurements spanned from Tuesday, June 27 at 3:00 P.M. through Thursday morning, June 30, 2010 at 11:00 A.M.. Weather was variable during the measurement period, and included periods of moderate winds and some rainfall. Temperatures ranged from about 60 to 80 degrees throughout the measurement period, with winds ranging from 0-8 mph. Wind data were measured nearby at station KMAMARBL4 in Salem Harbor, about ½ mile away. They could not be collected on-site with an anemometer due to lack of open secure locations; however, we believe that the hourly data from this location are acceptable due to its very close proximity to the turbine site.

Noise data at both locations were collected in one hour intervals. Figures 2 and 3 represent graphs of the L90 and Leq descriptors at the two sites for each one hour period. The graphs show that during the daytime periods, typical Leqs varied from approximately 44 to 68 dBA at the site near the Plummer home, and from about 41 to 57 dBA at the site near Winter Island Road. At night, Leqs ranged from 40 to 47 dBA at the Plummer home site and 35 to 53 dBA at the Winter Island Road site. The daytime L90 background values varied from approximately 40 to 51 dBA at the Plummer home site, and from about 39 to 46 dBA at the site near Winter Island Road. At night, L90s ranged from 39 to 43 dBA at the Plummer home site and 34 to 42 dBA at the Winter Island Road site.

Figure 1.

Noise Measurement Site Locations

Figure 2.

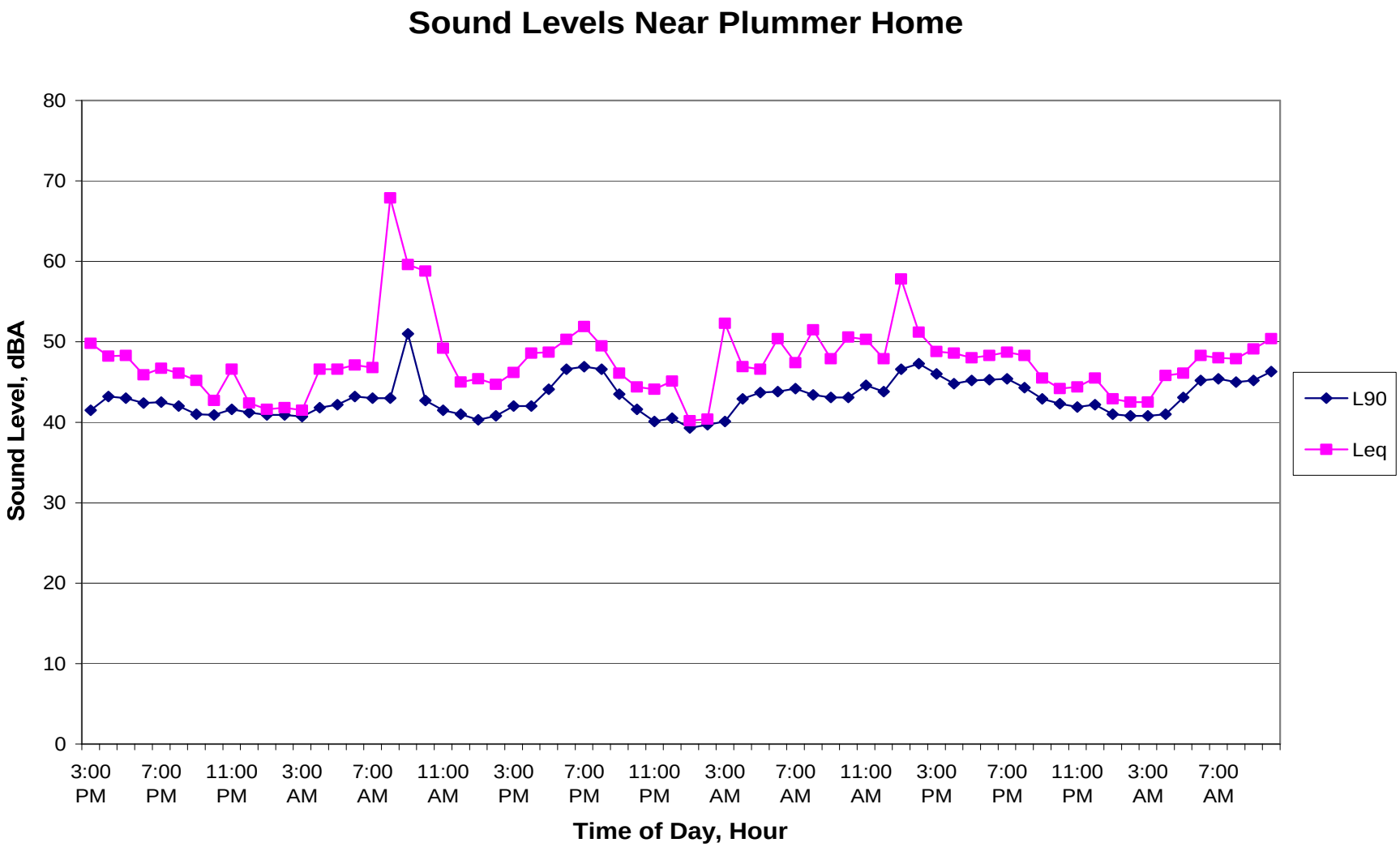
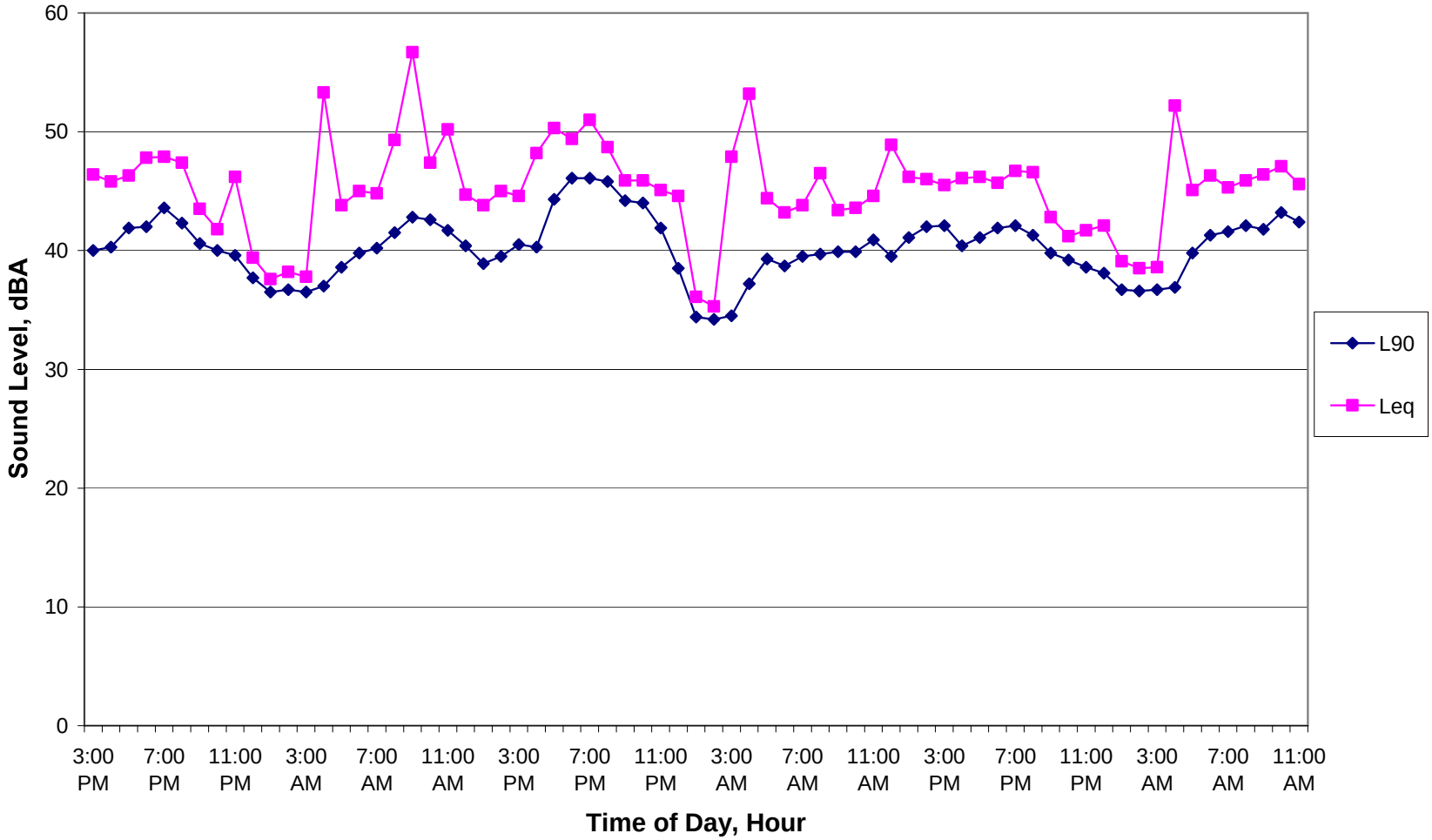

Sound Levels Near Plummer Home
Sound Level, dBA
80
70
60
50
40
30
20
10
0
3:00 PM
7:00 PM
11:00 PM
3:00 AM
7:00 AM
11:00 AM
3:00 PM
7:00 PM
11:00 PM
3:00 AM
7:00 AM
11:00 AM
3:00 PM
7:00 PM
11:00 PM
3:00 AM
7:00 AM
Time of Day, Hour
L90
Leq

Figure 3.

Sound Levels Near Residents on Winter Island Road



3.2 Ambient L90 levels

As discussed above in Section 2, the Mass DEP noise guidelines state that a noise source should not increase the broadband sound level by more than 10 dBA above ambient. Ambient is defined as the background L90 measured during equipment operating hours. A wind turbine only operates when there is sufficient wind speed to run it, which is generally 4 m/s (9 mph) at hub height or greater. Therefore, it is appropriate to determine the background L90 when winds are blowing at speeds of 4 m/s or higher, for purposes of comparison to the turbine noise emissions, if possible. In addition, the worst case background at this location would be for winds blowing from the south towards the residents from the turbine; with winds blowing from the west, noise from the power plant would become more noticeable and would add to the background.

In many locations, mostly rural, the background L90 is correlated with wind speed, and increases with increasing wind, which generates noise by interacting with trees and structures. This tends to vary some as we approach areas with more human activity. At Salem Harbor, background noise is from the nearby power plant, traffic in Salem, wind noise, insect noise, human activity at Winter Island Park, and surf. For the purposes of noise impact evaluation, we should be concerned with examining background levels during times with the lowest sound levels, between 1 and 5 A.M., as this is the time when the turbine sound would be most noticeable, even though only the traffic and human activity noise levels would actually be lower. Since winds were from the west during the only late night time period when the wind blew during the measurement period, carrying sound from the power plant to the area, we have conservatively estimated background from the two nights when there was no wind. Note that under these conditions, however, insect noise would still be a part of the background.

3.3 Comparison with Potential Turbine Noise levels

Table 1 shows a comparison with potential turbine noise levels at a wind speed of 8 m/sec. for a 1.5 MW Fuhrlander turbine, as taken from the modeling report. This shows clearly that the turbines would be well under the MADEP requirements under the conditions measured. At the Plummer home, in fact, the turbine noise would be below the quietest background level measured at this location.

Table 1.

Predicted Total Noise Levels from Proposed 1.5 MW Wind Turbine

Site Address	Predicted Turbine Leq dB(A)	Background Leq dB(A)	Total Leq dB(A)	Difference dBA
Plummer Home	39	40	43	3
Closest Residence on Winter Island Road	37	34	39	5
Fort Avenue and Winter Island Road*	40	34	41	7
Building Directly Beneath Turbine+	53	34	53	19

* Conservative estimate; actual background levels likely higher

+ Not a Residence

3.4 Conclusions

The quietest nighttime background measured at the nearest residences is about 34 decibels when the turbines would be operating under the conditions measured. The turbine sound would be well below the Massachusetts DEP noise guidelines at all relevant locations during the conditions measured. It appears likely that if measurements were made under any other different conditions with the wind at operational speed, the noise levels would not exceed the DEP requirements.

Description of Noise Metrics

This Appendix describes the noise metrics used in this report.

A.1 A-weighted Sound Level, dBA

Loudness is a subjective quantity that enables a listener to order the magnitude of different sounds on a scale from soft to loud. Although the perceived loudness of a sound is based somewhat on its frequency and duration, chiefly it depends upon the sound pressure level. Sound pressure level is a measure of the sound pressure at a point relative to a standard reference value; sound pressure level is always expressed in decibels (dB), a logarithmic quantity.

Another important characteristic of sound is its frequency, or "pitch." This is the rate of repetition of sound pressure oscillations as they reach our ears. Frequency is expressed in units known as Hertz (abbreviated "Hz" and equivalent to one cycle per second). Sounds heard in the environment usually consist of a range of frequencies. The distribution of sound energy as a function of frequency is termed the "frequency spectrum."

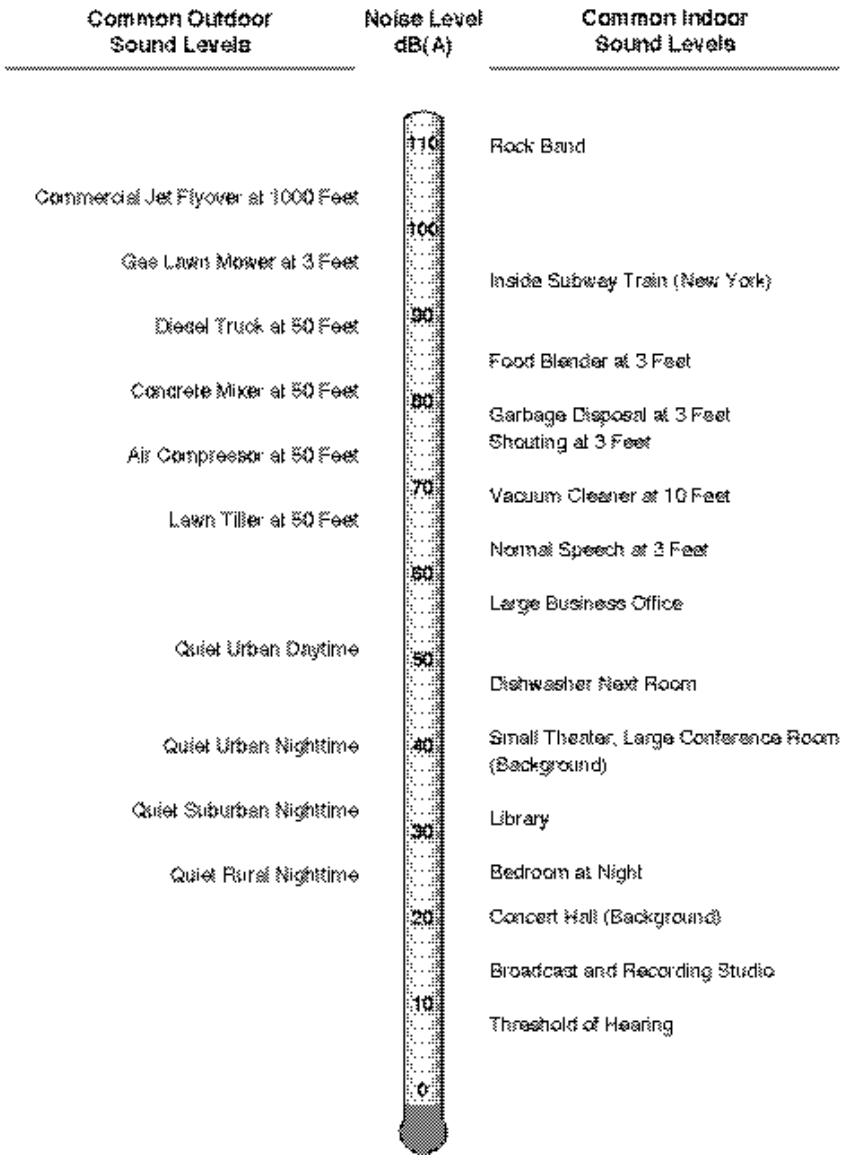
The human ear does not respond equally to identical noise levels at different frequencies. Although the normal frequency range of hearing for most people extends from a low of about 20 Hz to a high of 10,000 Hz to 20,000 Hz, people are most sensitive to sounds in the voice range, between about 500 Hz to 2,000 Hz. Therefore, to correlate the amplitude of a sound with its level as perceived by people, the sound energy spectrum is adjusted, or "weighted."

The weighting system most commonly used to correlate with people's response to noise is "A-weighting" (or the "A-filter") and the resultant noise level is called the "A-weighted noise level" (dBA). A-weighting significantly de-emphasizes those parts of the frequency spectrum from a noise source that occurs both at lower frequencies (those below about 500 Hz) and at very high frequencies (above 10,000 Hz) where we do not hear as well. The filter has very little effect, or is nearly "flat," in the middle range of frequencies between 500 and 10,000 Hz. A-weighted sound levels have been found to correlate better than other weighting networks with human perception of "noisiness." One of the primary reasons for this is that the A-weighting network emphasizes the frequency range where human speech occurs, and noise in this range interferes with speech communication. The figure below shows common indoor and outdoor A-weighted sound levels and the environments or sources that produce them.

A.2 Equivalent Sound Level, Leq

The Equivalent Sound Level, abbreviated L_{eq}, is a measure of the total exposure resulting from the accumulation of A-weighted sound levels over a particular period of interest -- for example, an hour, an 8-hour school day, nighttime, or a full 24-hour day. However, because the length of the period can be different depending on the time frame of interest, the applicable period should always be identified or clearly understood when discussing the metric. Such durations are often identified through a subscript, for example L_{eq1h}, or $L_{eq(24)}$.

L_{eq} may be thought of as a constant sound level over the period of interest that contains as much sound energy as (is "equivalent" to) the actual time-varying sound level with its normal peaks and valleys. It is important to recognize, however, that the two signals (the constant one and the time-varying one) would sound very different from each other. Also, the "average" sound level suggested by L_{eq} is not an



arithmetic value, but a logarithmic, or "energy-averaged" sound level. Thus, the loudest events may dominate the noise environment described by the metric, depending on the relative loudness of the events.

A.3 Statistical Sound Level Descriptors

Statistical descriptors of the time-varying sound level are often used instead of, or in addition to L_{eq} to provide more information about how the sound level varied during the time period of interest. The descriptor includes a subscript that indicates the percentage of time the sound level is exceeded during the period. The L_{50} is an example, which represents the sound level exceeded 50 percent of the time, and equals the median sound level. Another commonly used descriptor is the L_{10}, which represents the sound level exceeded 10 percent of the measurement period and describes the sound level during the louder portions of the period. The L_{90} is often used to describe the quieter background sound levels that occurred, since it represents the level exceeded 90 percent of the period.