Appendix F
Noise Analysis

APPENDIX F. NOISE ANALYSIS

Sound in air is a rapid fluctuation of air pressure above and below the static atmospheric pressure. Noise is usually defined as unwanted sound and is often associated with disruptions in normal activities or degradation of the quality of the environment. There are two types of noise sources: stationary and transient. Stationary sources are typically related to specific land uses, whereas transient sources move randomly through the environment along established paths. The total acoustical environment of a locale is the combination of the background or ambient sound with the unwanted noise.

Although sound can be easily measured, its perception is subjective and the physical response to noise complicates the analysis of its impact on people. People judge the relative magnitude of sound sensation in subjective terms such as "noisiness" or "loudness." However, the sound pressure magnitude can be objectively measured and quantified using a logarithmic ratio of pressures that yields the level of sound, utilizing the measurement scale of decibels (dB). The decibel generally adjusted to the A-weighted level (dBA) de-emphasizes very low frequencies to better approximate the human ear's range of sensitivity. In practice, the noise level of a sound source is measured using a sound level meter that includes an electronic filter corresponding to the A-weighting curve. Table F-1 defines the decibel along with other technical terms used in this analysis.

Even though the A-weighted scale accounts for a person's spectral response and therefore is commonly used to quantify individual events or general community sound levels, the degree of annoyance or other response effects also depends on several other perceptibility factors, including the following:

- Ambient (background) sound level.
- Magnitude of the event sound level with respect to the background.
- Spectral (frequency) composition (e.g., presence of tones).
- Duration of the sound event.
- Number of event occurrences and their repetitiveness.
- Time of day the event occurs.

Outdoor environments typically have continuously changing sound pressure levels where the energy-equivalent noise level (L_{eq}) is a commonly used metric because it averages the level of sound from multiple sources over a given period. Typically, over long periods of time, constant noises tend to be less noticeable than irregular or periodic (transient) noises. Figure F-1 lists sound levels for common noise sources.

Although community noise levels vary continuously, A-weighted noise levels can adequately indicate the level of environmental noise at any particular time. Most environmental noise includes a conglomeration of noise from distant sources, which creates a relatively steady background noise in which no particular source is identifiable. To describe the time-varying character of environmental noise, the statistical noise descriptors L_{10}, L_{50}, and L_{90} are commonly

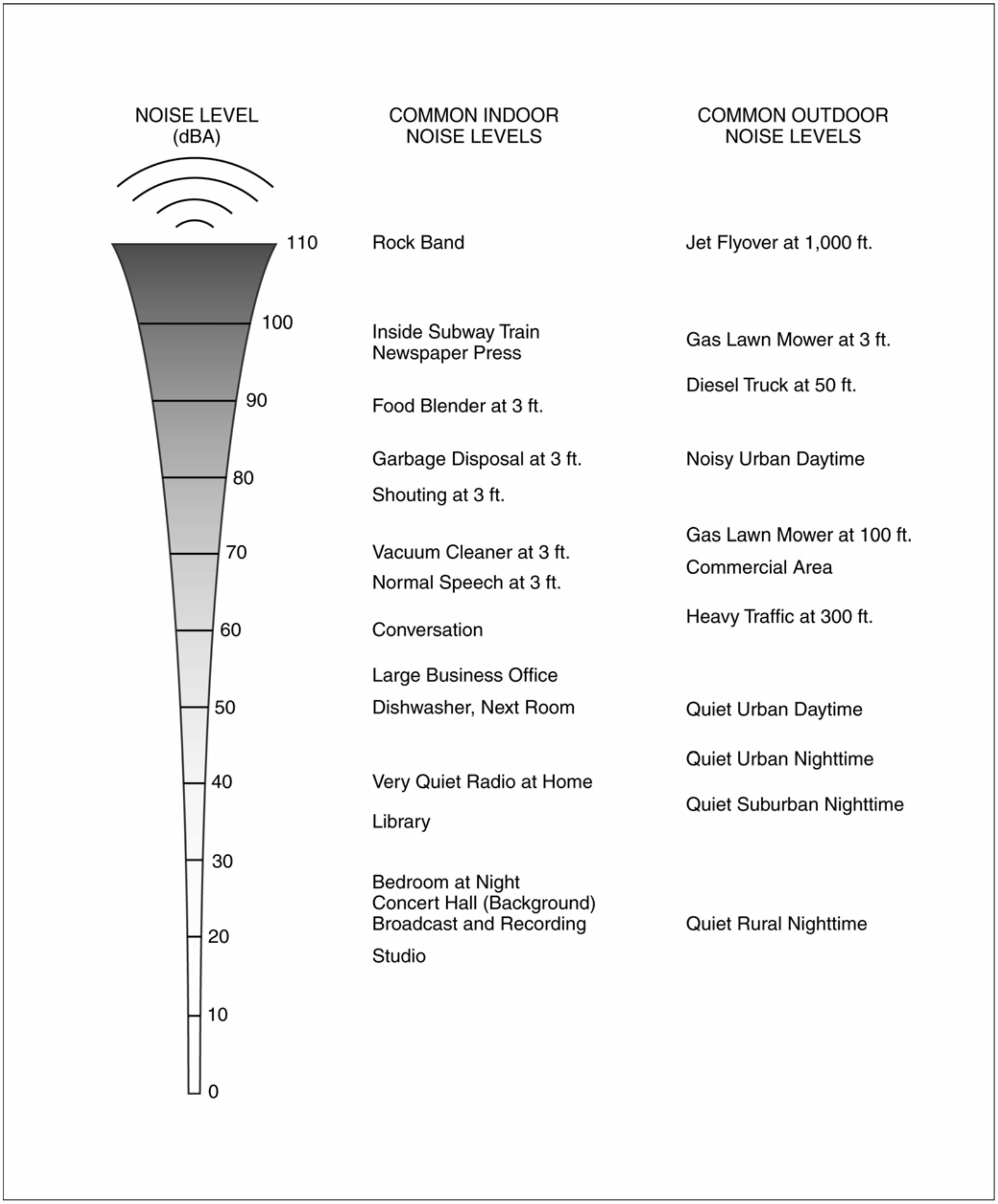

Figure F-1. Typical Sound Levels in Indoor and Outdoor Environments

Table F-1. Definitions of Noise-Related Terms

Term	*Definition*
Decibel (dB)	A unit describing the amplitude of sound equivalent to 20 times the logarithm, to the base 10, of the ratio of the pressure of the sound to the reference pressure of 20 μPa.
Frequency in megahertz (Hz)	The number of complete pressure fluctuations per second above and below atmospheric pressure.
A-Weighted Sound Level (dBA)	The sound pressure level in decibels as measured in a A-weighting filter network. The A-weighting de-emphasizes the very low frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise. All sound levels in this report are in the A-weighted scale.
L_{10}, L_{50}, L_{90}	The A-weighted noise levels that are exceeded 10 percent, 50 percent, and 90 percent of the time during the measurement period.
Equivalent Noise Level (L_{eq})	The average A-weighted noise level during the stated measurement period.
Community Noise Equivalent Level (CNEL)	The average A-weighted noise level during a 24-hour day, obtained after addition of 5 decibels in the evening from 7:00 P.M. to 10:00 P.M., and after addition of 10 decibels to noise levels in the night between 10:00 P.M. and 7:00 A.M.
Day-Night Noise Level (L_{dn})	The average A-weighted noise level during a 24-hour day, obtained after addition of 10 decibels to levels measured in the night between 10:00 P.M. and 7:00 A.M.
Ambient Noise Level	The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.

used. These noise descriptors are 10, 50, and 90 percent of an A-weighted noise level for a measured time period, respectively. These statistical sound levels, as well as the L_{eq} average level, are used in describing environmental noise.

In determining the daily level of environmental noise, it is important to account for the difference in human responses to daytime and nighttime noises. At night, exterior background noise levels are generally lower than daytime levels. However, most household noise also decreases at night, and exterior noise may become increasingly noticeable. Further, most people sleep at night and are very sensitive to noise intrusion. To account for human sensitivity to nighttime noise levels, a 24-hour descriptor, Day-Night Average Sound Level (L_{dn}), was developed. The L_{dn} divides the 24-hour day into a daytime period of 7:00 A.M. to 10:00 P.M. and a nighttime period of 10:00 P.M. to 7:00 A.M. Noise levels occurring during nighttime period are penalized 10 dB in determining the level for this descriptor. The Community Noise Equivalent Level (CNEL) is another 24-hour average that includes both an evening and a nighttime weighting. The evening period from 7:00 P.M. to 10:00 P.M. is given a 5 dB penalty. Otherwise, the CNEL has the same weighting and periods as the L_{dn} metric.

The effects of noise on people falls into three general categories, as follows:

- Subjective effects of annoyance and nuisance.
- Interference with activities such as speech, sleep and learning.
- Physiological effects such as hearing loss.

In most cases, the levels associated with environmental noise produce effects only in the first two categories. However, workers in industrial plants may experience noise effects in the last category. There is no completely effective way to measure the subjective effects of noise or the corresponding reactions of annoyance due to the wide variation in individual thresholds of annoyance and degrees to which people become acclimated to noise. Thus, an important way of determining a person's subjective reaction to a new noise source is by comparison to the existing environment to which they are accustom (the "ambient" environment). In general, the more a new noise exceeds the previous ambient noise level, the less acceptable the noise source will be to those who hear it.

With regard to increases in A-weighted noise levels, the following relationships are applicable to this analysis:

- Except in carefully controlled laboratory experiments, a 1-dB change cannot be perceived.
- Outside of a laboratory, a 3-dB change is considered a just-perceivable difference.
- A change in level of at least 5 dB is considered a noticeable change in noise level.
- A 10-dB change is subjectively heard as approximately a doubling in loudness and would almost certainly cause an adverse change in community response.

Some land uses are considered more sensitive to noise than others, due to the amount of noise exposure and the types of activities typically involved at the receptor location. The exposure to noise at these sensitive receptors is based on event source noise levels, exposure time, and exterior-to-interior sound insulation. Residences, motels, hotels, schools, libraries, religious institutions, hospitals, nursing homes, and parks are generally more sensitive to noise than are commercial and industrial land uses.