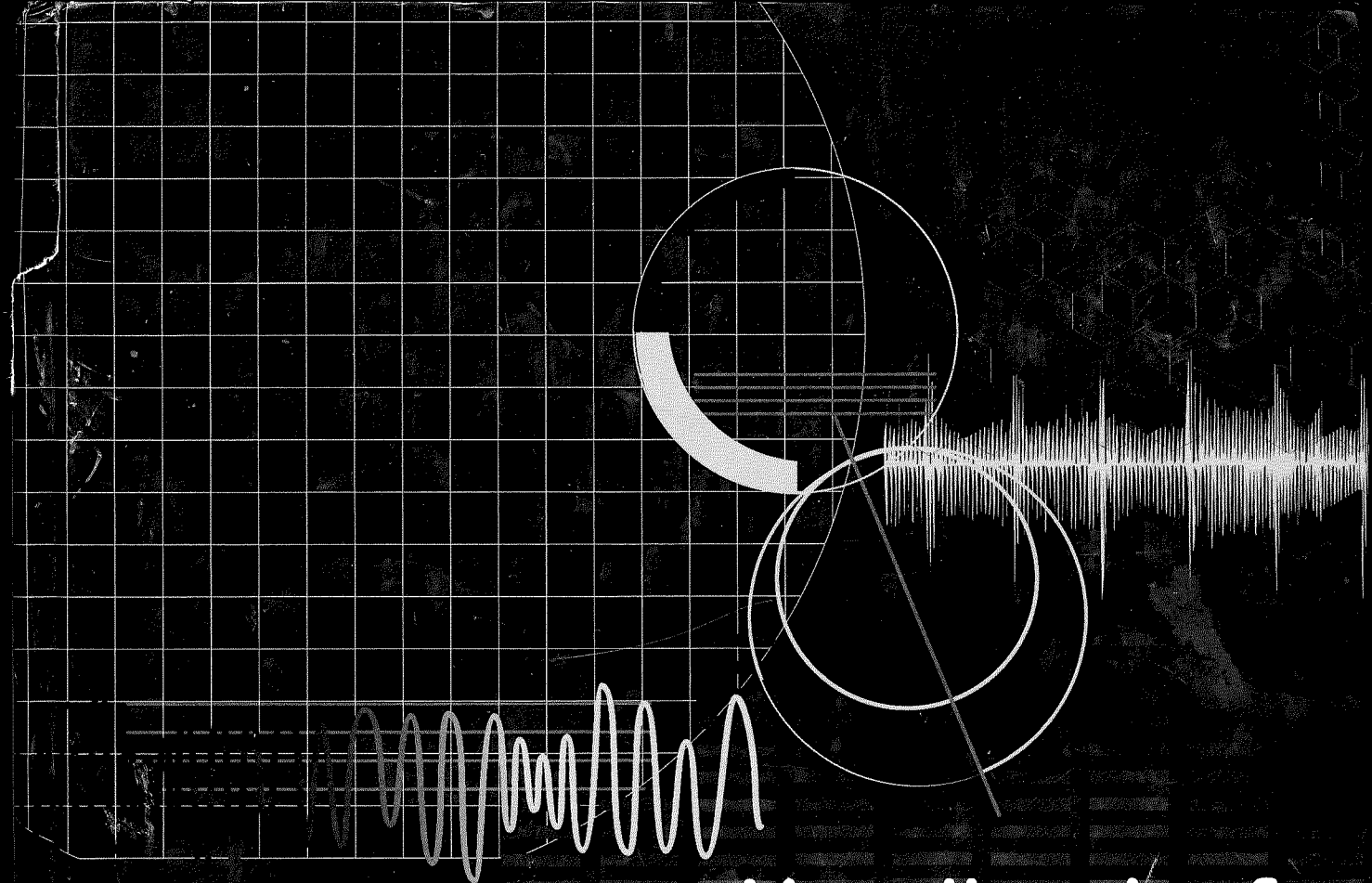
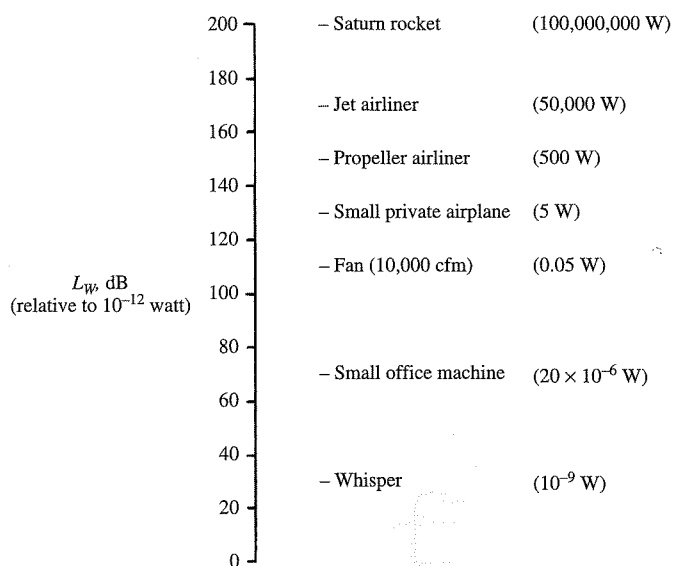




Handbook of

NOISE AND VIBRATION CONTROL

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Figure 13 Some typical sound power levels, L_w .

where I is the component of the sound intensity in a given direction and $I_{\text{ref}} = 10^{-12} \text{ W/m}^2$ is the reference sound intensity.

6.4 Combination of Decibels

If the sound pressures p_1 and p_2 at a point produced by two independent sources are combined, the mean square pressure is

$$\begin{aligned}
 p_{\text{rms}}^2 &= \frac{1}{T} \int_0^T (p_1 + p_2)^2 dt = \langle p_1^2 + 2p_1p_2 + p_2^2 \rangle_t \\
 &= \langle p_1^2 \rangle_t + \langle p_2^2 \rangle_t + 2\langle p_1p_2 \rangle_t \equiv \overline{p_1^2} + \overline{p_2^2} + 2\overline{p_1p_2}, \quad (35)
 \end{aligned}$$

where $\langle \rangle_t$ and the overbar indicate the time average $\frac{1}{T} \int_0^T (\) dt$.

Except for some special cases, such as two pure tones of the same frequency or the sounds from two correlated sound sources, the cross term $2\langle p_1p_2 \rangle_t$ disappears if $T \rightarrow \infty$. Then in such cases, the mean square sound pressures $\overline{p_1^2}$ and $\overline{p_2^2}$ are additive, and the total mean square sound pressure at some point in space, if they are completely independent noise sources, may be determined using Eq. (35a).

$$p_{\text{rms}}^2 = \overline{p_1^2} + \overline{p_2^2} \quad (35a)$$

Let the two mean square pressure contributions to the total noise be $p_{\text{rms}1}^2$ and $p_{\text{rms}2}^2$ corresponding to sound pressure levels L_{p1} and L_{p2} , where $L_{p2} = L_{p1} - \Delta$. The total sound pressure level is given by

the sum of the individual contributions in the case of uncorrelated sources, and the total sound pressure level is given by forming the total sound pressure level by taking logarithms of Eq. (35a)

$$\begin{aligned}
 L_{pt} &= 10 \log[(p_{\text{rms}1}^2 + p_{\text{rms}2}^2)/p_{\text{ref}}^2] \\
 &= 10 \log(10^{L_{p1}/10} + 10^{L_{p2}/10}) \\
 &= 10 \log(10^{L_{p1}/10} + 10^{(L_{p1}-\Delta)/10}) \\
 &= 10 \log[10^{L_{p1}/10}(1 + 10^{-\Delta/10})] \\
 &= L_{p1} + 10 \log(1 + 10^{-\Delta/10}) \quad (35b)
 \end{aligned}$$

where, L_{pT} = combined sound pressure level due to both sources

L_{p1} = greater of the two sound pressure level contributions

Δ = difference between the two contributions, all in dB

Equation (35b) is presented in Fig. 14.

Example 1 If two independent noise sources each create sound pressure levels operating on their own of 80 dB, at a certain point, what is the total sound pressure level? *Answer:* The difference in levels is 0 dB; thus the total sound pressure level is $80 + 3 = 83 \text{ dB}$.

Example 2 If two independent noise sources have sound power levels of 70 and 73 dB, what is the total level? *Answer:* The difference in levels is 3 dB; thus the total sound power level is $73 + 1.8 = 74.8 \text{ dB}$.

Figure 14 and these two examples do *not* apply to the case of two pure tones of the same frequency.

CHAPTER 127

ENVIRONMENTAL NOISE IMPACT ASSESSMENT

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1 INTRODUCTION

Community noise sources, such as transportation modes, recreational activities, and commercial and industrial developments, can impact residential areas negatively. Environmental noise impact assessments provide a mechanism to investigate the balance between the negative noise impacts of a proposed development project versus the benefits that that development project is expected to bring to the community. Existing community noise exposure guidelines are consulted when preparing the assessments. These are based on the premise that there is a level of noise that is acceptable to protect most humans, animals, and structures. If this level is likely to be exceeded by a proposed development, appropriate mitigation measures need to be selected with due consideration of cost and technical feasibility. The mitigated noise impact is assessed for acceptability to the potentially affected community as well as the benefit of the development to the community as a whole. In this chapter the terms *community noise* and *environmental noise* are used interchangeably.

2 ENVIRONMENTAL NOISE DESCRIPTORS

The definition of environmental noise given in the recent European Commission Environmental Noise Directive¹ is: "unwanted or harmful sound created by human activity outdoors, including noise emitted by means of transport and from industrial sites or industrial buildings."

Quantitative descriptors for environmental noise are generally based on the A-weighted decibel scale. The A-weighting is essentially a frequency filter that has a similar response to that of human hearing. As environmental noise is rarely constant in level, this time variation must be taken into consideration to provide a representative noise descriptor. A variety of such derived noise descriptors have been developed that incorporate time averaging of the sound pressure levels or integration of the energy within a sound over a defined period. Commonly used descriptors include:

- **Percentile Value, L_{An}** The A-weighted level exceeded for a percentage of a nominated time

period. The most commonly used are the L_{A10} , the level exceeded for 10% of the time period and so representative of the higher noise levels, and the L_{A90} , the level exceeded for 90% of the time period and considered representative of the background noise levels.

- **Equivalent Energy Level L_{Aeq}** The A-weighted sound pressure level for a continuous steady sound that has the same energy as the time-varying sound over the same time period. The L_{Aeq} is the basis for a number of derived descriptors discussed below.
- **Maximum Noise Level, L_{Amax}** The maximum noise level during the time period and often used as a criterion in conjunction with L_{Aeq} or L_{A10} to limit the highest noise levels in the noise.
- **Sound Exposure Level (SEL)** The noise level for a sound over a defined time period, such as 1s, that would have the same energy as the noise from a single event like a helicopter flyover or a train passby.
- **Perceived Noise Level (PNL)** The level of a sound that is considered to be equally noisy. It is calculated from the one-third octave band data.
- **Peak Noise Level, L_{Cpeak}** The peak C-weighted sound pressure level for impulse sound such as explosive noise. Note this environmental noise descriptor is not based on the A-weighting but is based on the C frequency weighting.

A number of derived noise descriptors are used for the assessment of noise impacts. The common ones include:

- **$L_{A10,18h}$** The average of the hourly L_{A10} values between 06:00 and 24:00 and used for the assessment of noise from road traffic.
- **$L_{Aeq,Nh}$** Average of L_{Aeq} over a defined number of hours such as 24 h, 9 h over a night, 15 h over a day, 1 h over a day, and so on, and used for wide range of environmental noises.