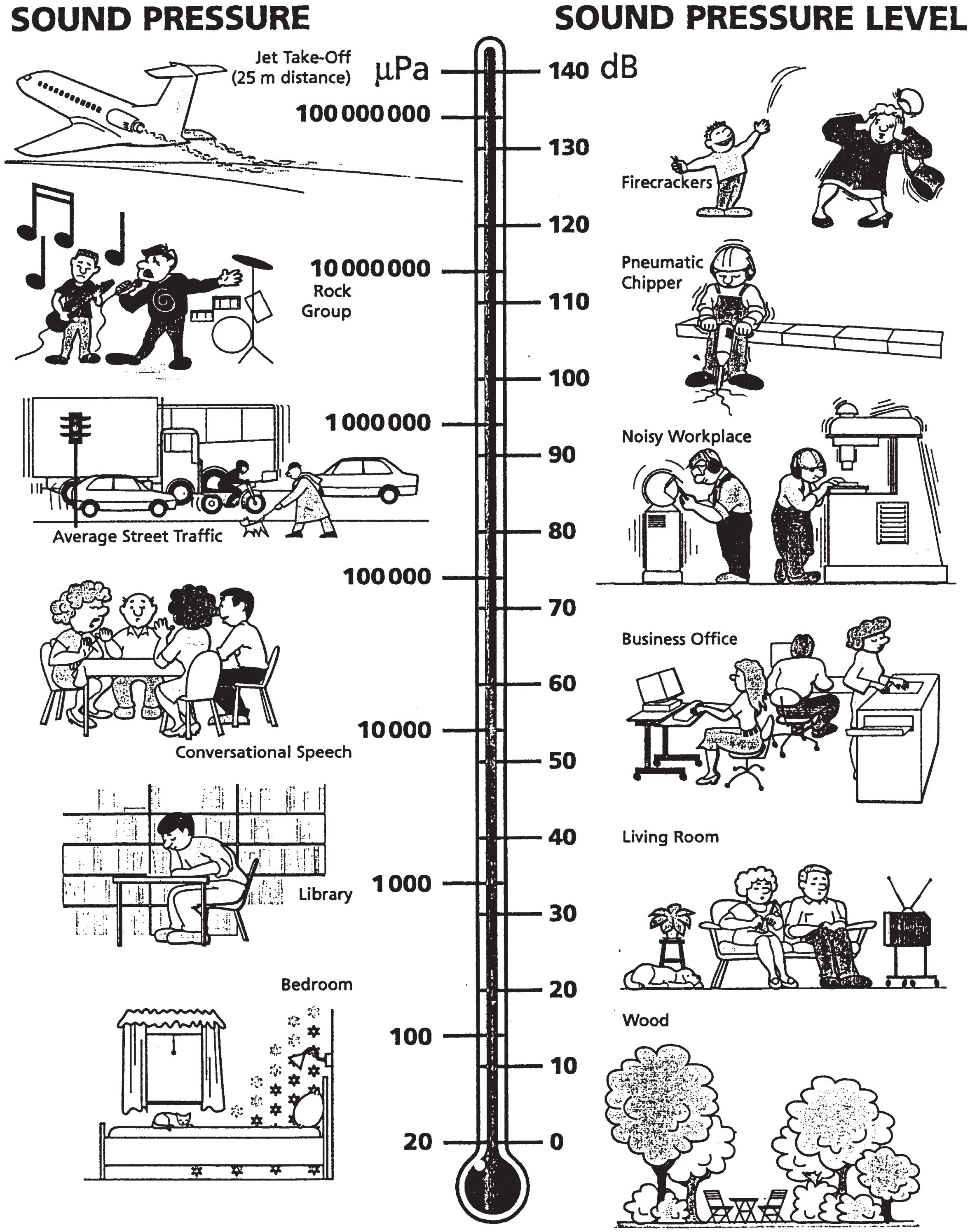

Figure 1.3.2 Typical sound pressure levels. (Source: Brüel & Kjær.)

The fact that the mean square sound pressures of independent sources are additive (cf. eq. (1.3.7)) leads to the conclusion that the levels of such sources are combined as follows:

$$L_{p,\mathrm{tot}} = 10\log\left(\sum_i 10^{0.1L_{p,i}}\right). \tag{1.3.9}$$

Another consequence of eq. (1.3.7) is that one can correct a measurement of the sound pressure level generated by a source for the influence of steady background noise as follows:

$$L_{p,\mathrm{source}} = 10\log\left(10^{0.1L_{p,\mathrm{tot}}} - 10^{0.1L_{p,\mathrm{background}}}\right). \tag{1.3.10}$$

This corresponds to subtracting the mean square sound pressure of the background noise from the total mean square sound pressure as described in example 1.3.5. However, since all measurements are subject to random errors, the result of the correction will be reliable only if the background level is at least, say, 3 dB below the total sound pressure level. If the background noise is more than 10 dB below the total level the correction is less than 0.5 dB.

Example 1.3.5

Expressed in terms of sound pressure levels the inverse distance law states that the level decreases by 6 dB when the distance to the source is doubled.

Example 1.3.6

When each of two independent sources in the absence of the other generates a sound pressure level of 70 dB at a certain point, the resulting sound pressure level is 73 dB (**not** 140 dB!), because $10\log 2 \simeq 3$. If one source creates a sound pressure level of 65 dB and the other a sound pressure level of 59 dB, the total level is $10\log(10^{6.5} + 10^{5.9}) \simeq 66$ dB.

Example 1.3.7

Say the task is to determine the sound pressure level generated by a source in background noise with a level of 59 dB. If the total sound pressure level is 66 dB, it follows from eq. (1.3.10) that the source would have produced a sound pressure level of $10\log(10^{6.6} - 10^{5.9}) \simeq 65$ dB in the absence of the background noise.

Example 1.3.8

When two sinusoidal sources emit pure tones of the same frequency they create an interference field, and depending on the phase difference the total sound pressure amplitude at a given position will assume a value between the sum of the two amplitudes and the difference:

$$\big||A| - |B|\big| \le \left|A\mathrm{e}^{\mathrm{j}\omega t} + B\mathrm{e}^{\mathrm{j}\omega t}\right| = |A+B| = \left||A|\mathrm{e}^{\mathrm{j}\varphi_A} + |B|\mathrm{e}^{\mathrm{j}\varphi_B}\right| \le |A| + |B|.$$

For example, if two pure tone sources of the same frequency each generates a sound pressure level of 70 dB in the absence of the other source then the total sound pressure level can be anywhere between 76 dB (constructive interference) and - ∞ dB (destructive interference). Note that eqs. (1.3.7) and (1.3.9) do **not** apply in this case because the signals are not uncorrelated. See also figure 1.9.2 in the Appendix.

Other first-order acoustic quantities, for example the particle velocity, are also often measured on a logarithmic scale. The reference velocity is 1 nm/s = 10^{-9} m/s.[23] This reference is also used in measurements of the vibratory velocities of vibrating structures.

The acoustic second-order quantities sound intensity and sound power, defined in chapter 1.5, are also measured on a logarithmic scale. The sound intensity level is

[23] The prefix n (for 'nano') represents a factor of 10^{-9}.