The sound pressure level $SPL(r) = L_p(r) \equiv 10\log_{10}\left(p^2(r)/p_o^2\right) = 20\log_{10}\left(p(r)/p_o\right)(dB)$ and/or sound intensity level $SIL(r) = L_I(r) \equiv 10\log_{10}\left(I(r)/I_o\right)(dB)$ depend on the power *P* and directivity factor *Q* of the sound source, the separation distance *r* from the sound source, and the strength of the reflected sound.

In a ***free-field*** situation (*i.e*. far away from any reflecting and/or confining/constricting surfaces), since $I = p^2/\rho_o c$, we have shown that, to within ~ 0.1 *dB*:

$$SIL = L_I \equiv 10\log_{10}\left(I/I_o\right) = SPL = L_p \equiv 10\log_{10}\left(p^2/p_o^2\right) = 20\log_{10}\left(p/p_o\right)(dB):$$

The ***free-field*** sound intensity ***directly*** in front of, and at a distance r away from a sound source having sound power *P* (*Watts*) and directivity factor *Q* associated with it is:

$$I_{ff}(r) = \frac{QP}{4\pi r^2}\left(Watts/m^2\right)$$

Using the above formulae, it is a straightforward algebraic exercise (please work it out!!!) to show that the ***free-field*** sound pressure level ***directly*** in front of this sound source is:

$$SPL_{direct}(r) = L_p^{direct}(r) = L_{Pwr} + 10\log_{10}\left(Q/4\pi r^2\right)\ (dB)$$

Sound Fields:

In analogy to the concept of an electric field distributed in 3-D space in electromagnetism, in acoustical physics we characterize the distribution of sound in 3-D space as a ***sound field***.

The nature of a 3-D sound field varies with the distance *r* from the source and depends on details of the acoustic environment, as shown in the figure below: