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Architectural Acoustics

by M. David Egan

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CHANGES IN SOUND LEVEL

The table below is an approximation of human sensitivity to changes in sound level. Sound intensity is not perceived directly at the ear; rather it is transferred by the complex hearing mechanism to the brain where acoustical sensations can be interpreted as *loudness*. This makes hearing perception highly individualized. Sensitivity to noise also depends on frequency content, time of occurrence, duration of sound, and psychological factors such as emotion and expectations (cf., O. L. Angevine, "Individual Differences in the Annoyance of Noise," *Sound and Vibration*, November 1975). Nevertheless, the table is a reasonable guide to help explain increases or decreases in sound levels for many architectural acoustics situations.

Change in Sound Level (dB)	Change in Apparent Loudness
1	Imperceptible (except for *tones*)
3	Just barely perceptible
6	Clearly noticeable *
10	About twice (or half) as loud
20	About 4 times (or one-fourth) as loud

* For example, distance to the point source outdoors is halved or doubled.

The change in intensity level (or *noise reduction*, abbreviated NR) can be found by:

$$NR = L_1 - L_2$$

and

$$NR = 10 \log \frac{I_1}{I_2}$$

where NR = difference in sound levels between two conditions (dB)
I_1 = sound intensity under one condition (W/m^2)
I_2 = sound intensity under another condition (W/m^2)

Note: By substitution of the inverse-square law expression from page 11 into the above formula

$$NR = 10 \log \left(\frac{d_2}{d_1}\right)^2$$

and therefore, in terms of distance ratio d_2/d_1

$$NR = 20 \log \left(\frac{d_2}{d_1}\right)$$

for point sources outdoors, where d's are the distances.

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