

Demonstration 4.1

dB SPL = dB IL

Illustration that dB SPL and dB IL are equivalent for sound in air.

We can illustrate that dB IL and dB SPL are equivalent for sound in air by showing that the reference pressure and the reference intensity are equivalent.

Recall that p at threshold is the pressure reference of $20 \times 10^{-6} \text{ N/m}^2$, and using Eq. 4-1, $I_l = p_l^2/Z$, we can solve for I_l at threshold:

$$\text{So, } p_l = 20 \times 10^{-6} \text{ N/m}^2$$

$$I_l = (20 \times 10^{-6} \text{ N/m}^2)^2 / 400 \text{ N}\cdot\text{s/m}^3$$

$$I_l = 1 \times 10^{-12} \text{ N}^2/\text{m}^4 \cdot \text{m}^3/\text{N}\cdot\text{s},$$

$$I_l = 1 \times 10^{-12} \text{ N/m}\cdot\text{s},$$

Now, we need to show that the units are correct (because intensity is quantified in watts/m²).

Multiplying both the numerator and the denominator by m·s:

$$I_l = 1 \times 10^{-12} (\text{N m}\cdot\text{s} / ((\text{m}\cdot\text{s}) (\text{m}\cdot\text{s}))),$$

$$I_l = 1 \times 10^{-12} (\text{N m}\cdot\text{s} / \text{m}^2\cdot\text{s}^2),$$

This is equivalent to

$$I_l = 1 \times 10^{-12} (\text{N}\cdot\text{m/s}\cdot\text{m}^2),$$

Note that 1 watt = 1 N·m/s, so we can rewrite I_l as:

$$\text{So, } I_l = 1 \times 10^{-12} \text{ watts/m}^2$$

Which results in the intensity reference.

As such, dB SPL = dB IL for sound in air.