Standard/Classic/Homogeneous Bed Thickness Weighting for Laminated Beds

The standard/classic/homogeneous approach generally uses **bed thickness weighting/mixing:** *it forms the baseline for comparison within the newer LVPM program that uses theTransmission Probability Method (TPM) to handle laminated beds.* Suppose Material1 (sand) has a thickness Δ_1 and Material2 (shale) has thickness Δ_2. The total thickness of one laminar cycle is $\Delta = \Delta_1 + \Delta_2$ and so the corresponding bed thickness weights are

$$W_1 = \Delta_1 / \Delta \text{ and } W_2 = \Delta_2 / \Delta . \qquad \textbf{(1)}$$

For the **neutrons**, all macroscopic cross-sections for all energies and for both absorption and elastic scattering processes obey simple bed thickness weighting.

$$\Sigma^i_{LAM} = W_1 * \Sigma^i_1 + W_2 * \Sigma^i_2 \qquad \textbf{(2)}$$

For the **gamma rays**, these rules are more complex even in the homogeneous case. Mixing rules for the linear attenuation coefficients (LAC) at various energies are central to both the LVPM homogeneous and heterogeneous calculations. For the gammas, tables of mass attenuation coefficients (MAC) from Hubbell and Seltzer are used and LAC is computed from the general relationship

$$LAC = \rho * MAC, \qquad \textbf{(3)}$$

where ρ is bulk density. Bed thickness weighting is applied to ρ and MAC as follows. Total Material1 and Material2 atomic weights are computed and so the bed thickness average atomic weight is

$$AverageAtomicWeight = W_1 * AtomicWeight_1 + W_2 * AtomicWeight_2 \qquad \textbf{(4)}$$

Then the Material1 and Material2 mass fractions are

$$MassFraction_1 = W_1 * AtomicWeight_1 / AverageAtomicWeight \qquad \textbf{(5)}$$

and

$$MassFraction_2 = W_2 * AtomicWeight_2 / AverageAtomicWeight. \qquad \textbf{(6)}$$

These mass fractions are used to compute mass attenuation coefficients at all gamma energies. The final gamma ray mixing rule needed for the classic/homogeneous LVPM computation of the linear attenuation coefficients involves the bulk density itself:

$$\rho^{HOMO}_{LAM} = W_1 * \rho_1 + W_2 * \rho_2 . \qquad \textbf{(7)}$$

This rule follows from a proper accounting of the masses present in the sand and shale laminae, assuming their materials are homogeneous with infinitesimal pore sizes.