Brief summary on the RSP calculation by Valentina Giacometti

Steps to calculate the RSP of a material m, knowing its composition (***R. Schulte***, 2013):

1. Relationship between electron density and physical density of a material made of a mixture of elements:

$$\rho_{em} = \rho_m N_A \left[\sum_i \left(w_i \frac{Z_i}{A_i} \right) \right]$$

N_A is the Avogadro's number, w_i is the fraction by weight of the element i, Z_i is the atomic number of the element i, A_i is the mass number of the element i, ρ_m is the density of the material m.

2. Relative electron density of a material:

$$RED_m = \frac{\rho_{em}}{\rho_{ew}}$$

ρ_{em} is the electron density of the material m and ρ_{ew} is the electron density of water ($\rho_{ew} = 3.34 \cdot 10^{23}(g/cm^3)$).

3. Relative stopping power:

$$RSP_m(E) = RED_m \left[\frac{ln\left(\frac{2m_e c^2}{I_m}\frac{\beta^2}{1-\beta^2}\right) - \beta^2}{ln\left(\frac{2m_e c^2}{I_w}\frac{\beta^2}{1-\beta^2}\right) - \beta^2} \right]$$

m_e is the electron mass, $\beta = \sqrt{1 - \left(\frac{E_p}{E+E_p}\right)^2}$, I_m is the mean excitation energy of the material m and I_w is the mean excitation energy of the water (it can be calculated - see below - or $I_w = 75eV$ from NIST).

The problem is the definition of I_m for material that are not "common" and cannot be find in the NIST database (e.g. 5-year-old cortical bone v.s. NIST standard cortical bone from ICRP).

To calculate the mean excitation energy of a compound or mixture of elements, according to the Bethe theory, the following formula can be used (***Radioactivity: Introduction and Early History***, by L'Annunziata, Michael F.):

$$< I >= exp \left[\frac{\Sigma_j w_j (Z_j/A_j) ln I_j}{\Sigma_j w_j (Z_j/A_j)} \right]$$

w_j, Z_j, A_j and I_j are respectively the fraction by weight, the atomic number, the mass number and the mean excitation energy of the element j.