(6.16) In a sample of 10.4 TBq of old fission products, the average γ-ray energy is 0.5 MeV and on the average 0.4 γ's are emitted per β-decay. (a) What is the lead shielding required to reduce the γ-flux to $10^2\ \gamma\ cm^{-2}s^{-1}$ at 1.5 m from the source assuming only exponential absorption? (b) What is the relaxation length? (c) What is the build-up factor?

Solution: Because we will handle scattered radiation by the build-up factor the appropriate curve to use in Figure 6.17 (Lead) is the one labeled "Total Attenuation". At 0.5 MeV this gives a value of 0.15 cm^2/gm for μ_o/ρ.

$Bq := sec^{-1}$ $\quad A := 10.4\cdot 10^{12}\cdot Bq$ $\quad n := 0.4$ $\quad \gamma/\beta$

$\rho := 11.3\cdot gm\cdot cm^{-3}$ $\quad \mu_o := 0.15\cdot cm^2\cdot gm^{-1}$ $\quad \mu := \mu_o\cdot \rho$

$r := 1.5\cdot 100\cdot cm$ $\quad \phi := 10^2\cdot cm^{-2}\cdot sec^{-1}$ $\quad \gamma/cm^{-2}s^{-1}$

$$x := \frac{\ln\left(\frac{n\cdot A}{4\cdot\pi\cdot r^2\cdot\phi}\right)}{\mu}$$

Derived from eqn. (6.26)

(a) Shield thickness, *x*, is $\quad x = 0.07\cdot m$ $\quad$ or $\quad x = 7.02\cdot cm$

(b) Relaxation length = $\quad \mu\cdot x = 11.899$

(c) From Fig. 6.20; build-up factor = 2.5