Dose Assessment Due to Inhalation of Plutonium Nanoparticles

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Introduction

Experience has shown that nanoparticles behave differently in terms of deposition and clearance from the respiratory tract as compared to micron-sized particles. However, currently used HRTM models have not have addressed the very particular aspects of inhalation, deposition and further distribution of radioactive nanoparticles in the human body. Plutonium is one of the most important radionuclides in the nuclear industry and production of it in nanoparticle form is not negligible. Therefore, this study was done to investigate deposition to the respiratory tract, clearance, and subsequent distribution to systemic organs based on animal data and human studies.

Objectives

1) To obtain compound specific blood absorption parameters of plutonium nanoparticles deposited in the respiratory tract.

2) Determine the impacts on interpretation of bioassay measurements associated with the inhalation of plutonium nanoparticles when compared against the corresponding results for micron-sized particles.

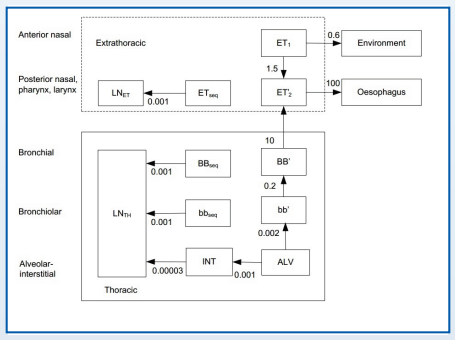
Methods

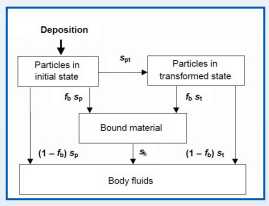
1) Using SAAM II propose and test a plutonium biokinetic model using experiments involving injection of plutonium compounds in animals plus results from existing human data.
(See Systemic Model Parameters to the right)

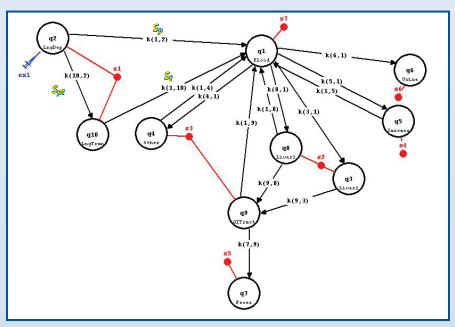
2) Derive specific absorption parameters for Pu compounds using inhalation animal data.
(See Fit Inhalation Parameters to the right)

3) Test the derived parameters against RatDose software.

4) Derive intake retention fractions and dose coefficients for the customized model.







Fit Inhalation Parameters

k(1,2) Sp = 6.349

k(10,2) Spt = 2.178

k(1,10) St = 0.078

Systemic Model Parameters

k(1,4) = 0.015

k(4,1) = 0.048

k(1,9) = 0.040

k(1,8) = 0.014

k(8,1) = 0.747

k(9,8) = 0.046

k(3,1) = 0.149

k(9,3) = 100

k(7,9) = 0.740

k(1,5) = 0.005

k(5,1) = 2.382

k(6,1) = 0.111

Discussion/Conclusion

Though these data are preliminary and may change as the model is refined; the initial data suggests that due to an observed faster blood absorption of inhaled plutonium nanoparticles, even oxide compounds of plutonium nanoparticles can be classified between Type F and Type M.

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LA-UR-12-10339