

The Importance of Plutonium Binding in Human Lungs

A. Birchall¹, M. Puncher², S. Tolmachev³

¹*Global Dosimetry Ltd., UK;* ²*Public Health England, UK;* ³*United States Transuranium and Uranium Registries*

Epidemiological studies have shown that the main risk arising from exposure to plutonium aerosols is lung cancer, with other detrimental effects in the bone and liver. A realistic assessment of these risks, in turn, depends on the accuracy of the dosimetric models used to calculate doses in such studies. A state of the art biokinetic model for plutonium, based on the current ICRP biokinetic model, has been developed for such a purpose in an epidemiological study involving the plutonium exposure of Mayak workers in Ozersk, Russia. One important consequence of this model is that the lung dose is extremely sensitive to the fraction (fb) of plutonium that becomes bound to lung tissue after it dissolves. It has been shown that if just 1% of the material becomes bound in the upper airways, it will double the lung dose. Furthermore, fb is very difficult to quantify from experimental measurements. This paper summarizes the work carried out so far to quantify fb. Bayesian techniques have been used to analyse data from different sources, including both humans and dogs, and the results suggest a small, but non-zero, fraction of <1%. A Bayesian analysis of 20 Mayak workers exposed to plutonium nitrate suggests an fb between 0 and 0.3%. Based on this work, the ICRP is currently considering the adoption of a value of 0.2% for the default bound fraction for all actinides in the forthcoming recommendations on internal dosimetry. In an attempt to corroborate these findings, further experimental work has been carried out by the United States Transuranium and Uranium Registries (USTUR). This work has involved direct measurements of plutonium in the upper airways of workers who have been exposed to plutonium nitrate. Without binding, one would not expect to see any activity remaining in the upper airways at long times after exposure, since it would have been cleared by the natural process of mucociliary clearance. Further supportive work on workers exposed to plutonium oxide is planned. This paper will ascertain to what extent these results corroborate the previous inferences concerning the bound fraction.

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