A Review of Plutonium Dose Assessment Methodology

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Body of Abstract: The threshold of detection for direct measurement of plutonium in the body is relatively high and equates to a dose that would be several times greater than recommended annual dose limits. A more complex process involving indirect measurements on biological samples (normally urine) and mathematical models that describe plutonium metabolism is therefore routinely used to assess plutonium doses. Having recently completed over eight thousand internal dose assessments for an epidemiological study of Sellafield plutonium workers we find ourselves uniquely placed to review the current state of plutonium dose assessment methodology.

Our assessment processes have been developed and refined over many years, we believe the methodology and data fitting techniques we currently employ could be described as being representative of the state of the art. We use the Jones plutonium excretion function, the ICRP67 biokinetic model, the ICRP66 lung model and the ICRP30 gastrointestinal tract model to produce an idealised mathematical description of excretion and retention of plutonium in the body following exposure. A sophisticated maximum likelihood data fitting technique is used to deal with issues that commonly arise when performing assessments e.g. multiple exposures, random variation in urinalysis results and results that are below the limit of detection. The assessment software used to perform the above functions employs modules developed for the Integrated Modules for Bioassay Analysis (IMBA) project that have been extensively validated. However, comparison with autopsy analyses shows that, in general, even these state of the art assessments significantly overestimate uptake and hence dose. We consider how we could improve on existing methodology and fitting techniques so as to increase the fidelity of future plutonium dose assessments.