The Mayak Worker Dosimetry System (MWDS-2013): How to Reduce Hyper-Realisations to Realisations

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Two important aspects in which the MWDS-2013 output (absorbed dose to organs calculated in each calendar year) differs from previous data bases (MWDS-2008 and DOSES-2005) are that they have been designed to (a) deal explicitly with uncertainties in model parameters, and (b) differentiate parameters that are considered to be shared (unknown, but having the same value for all workers) and unshared (unknown, but having different values between workers). A multiple-realisation approach is used to preserve information on the effects of shared and unshared parameters both for internal and external doses. Previously, a single realisation (a set of organ doses: one for each worker in the cohort) was calculated using the best estimates of parameter values only. In MWDS-2013, a set of 1000 realisations is produced, to reflect the uncertainty in assumed model parameters: each realisation using a different set of parameter values. Within each realisation, shared parameter values are fixed throughout the cohort, while unshared parameters are allowed to vary between workers. One problem is that because the calculation of organ dose is Bayesian, the estimate for each organ dose is not just a single value, but is itself a distribution (hyper-dose). Technically, it is the probability density of dose given the sampled set of parameter values and given the data for that worker. Thus, in our case, the realisations consist not of single doses, but distributions of doses. The term hyper-realisation is used to differentiate this from the more conventional realisation. Although the multiple hyper-realisation in principle contains all of the necessary information on parameter uncertainty, including shared and unshared parameters, in order to make preliminary epidemiological analyses tractable, and also for consistency with the external doses, it was required to convert the hyper-realisations to realisations. The aim of this paper is to discuss the different approaches that were considered to do this, and to define the method that was eventually chosen. Single spot (point) estimates of dose (for each worker) were also calculated to support the epidemiological analysis. The different methods for obtaining these and the implications are also discussed.

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