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Theoretical study on physiochemical properties and dispersion of radioactive particles/aerosols and their effect on minimum detectable dose in exposed humans for European Spallation Source releases

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The European Spallation Source (ESS) is a neutron facility under construction near Lund, Sweden. The facility will produce neutrons via proton-induced spallation reactions for various scientific applications. Under normal operation, many radionuclides will be produced and contained inside the tungsten target. However, in the scenario of the loss of coolant, it is predicted that these radionuclides can be spread into the ambient environment in the form of aerosol particles, potentially causing internal contamination in exposed workers and members of the public. There is little research into the possible detectability of members of the public contaminated with spallation source products in terms of minimum detectable dose (MDD) and how this quantity varies depending on the measurement conditions. This study aims to examine the variability in MDD caused by the variability in particle physiochemical properties for selected dosimetrically important radionuclides such as 148Gd (pure alpha emitter with a half-life of 84±4 y), 187W, 172Hf, 182Ta and 125I (gamma emitters, with half-lives of 23.7 h, 1.87 y, 114.4 d, and 59.49 d, respectively). Using an in-house Lagrangian dispersion model, we estimated parameters describing particle size distributions and spatial dispersions in a radius of 10 km from the ESS. The corresponding committed effective dose was calculated using gamma-ray spectra simulated with Nucleonica and ICRP's tabulations for occupational intakes of radionuclides. Variations in MDD at various distances from the ESS and over time after the accident were calculated using the Monte Carlo method. This project is part of ongoing efforts to design a methodology for internal contamination assessment from ESS radionuclides.

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