Effective Dose Scaling Factors for Inhalation Dose Assessment Using Cascade Impactor in NORM Industry

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Radiation dose due to the inhalation of airborne particulates containing radioactive materials depends of particle size distribution. The size distribution of airborne particulates can be directly measured by a cascade impactor. For inhalation dose assessment, radioactivity distribution in airborne particulates is generally assumed to be concentrated at one mean size of each impactor stage. However, radioactivity of particulates collected at each stage shows various distributions with particulate size in reality. The objective of this study was to calculate effective dose scaling factor (SFE) with each stage of cascade impactor for 238U and 232Th radionuclides. The information of airborne particulate distribution was obtained from actual measurement data using cascade impactor at monazite industry. To explore more realistic assumptions, the radioactivity distributes uniformly (1:1), linearly increases (1:2, 1:5) and linearly decreases (2:1, 5:1) across the particle size interval for each cascade impactor stage. Effective dose scaling factors, SFE, can thus be developed as defined by the ratio of the effective dose determined under a uniform or linear distribution to that under a single mono-size distribution for each stage. Assuming uniform radioactivity distribution, values of SFE were 0.95-0.99 for 3th, 4th stage. It means that downward adjustments of 1-5% are required to the effective dose. In Contrast, upward adjustments of maximum 21% are required to the effective dose for 0th. In case of linearly increasing distributions, upward adjustment of maximum 16% is required to the effective dose and downward adjustments of maximum 26% is required to the effective dose. In case of linearly decreasing distributions, upward adjustment of maximum 30% is required to the effective dose and downward adjustments of maximum 5% is required to the effective dose. The methodology of inhalation dose assessment developed by this study can be used for accurate inhalation dose assessment in NORM industry.

Keywords: NORM, Inhalation dose, Particle size distribution, Scaling factor

[1] International Commission on Radiation Protection, (1994). Human respiratory tract model for radiological protection, ICRP Publication 66.