A Study on the Effect of Internal Exposure of Worker due to Radioactive Aerosols Generated During NPP Dismantling Process

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1. Introduction

Radioactive aerosols are generated during the cutting and melting processes of the nuclear power plant decommissioning. These aerosols can infiltrate into the body of the worker through the respiratory system and they are the main factors inducing internal exposure. The infiltrated radioactive aerosols accumulate in different parts of the respiratory system depending on the size of the particles. Generally, aerosols between the size of 10 and 15um deposit on the mouth and nose while those between 5 and 10um and those between 1 and 5um deposit on the upper bronchus and the alveoli, respectively. Particularly, radioactive aerosols deposited on the alveoli are absorbed into the blood vessel due to osmotic action, resulting in whole-body irradiation. This study evaluated the internal exposure of workers by utilizing the production and size distribution of radioactive aerosols during the melting processes of the nuclear power plant decommissioning.

2. Main Title

2.1 Internal Exposure Evaluation Code and Selection of Input Data

This study used BiDAS (Bioassay Data Analysis Software) whose reliability was verified by verifying the results values using IMBA and IMIE. The BiDAS Code was developed by KAERI (Korea Atomic Energy Research Institute) in 2009.

2.1.1 Respiratory Rate. The respiratory rate of workers is directly related to the intake of particles in the air. This study believed that it is difficult to define the actual intensity of work of workers, and applied 1.20m^3/hr, the average respiratory rate of male adults during the simple work suggested by ICRP-66. Table 1 shows the average respiration rate of workers in ICRP-66.

Table 1. The average respiration rate of workers according to type of activity

Activity	Spent Time	Respiratory Rate(m^3/hr)
Occupational Work	Minor Work	1.20
	Intense Work	1.68

2.1.2 Work Time. This study also believed that it is difficult to define the work time like the respiratory rate, and applied 8 hours a day on average and 5 days a week, the general work time in Korea.

2.1.3 Quantity of Aerosols by Nuclide. The nuclide data, collected in the melting process conducted by the Kozloduy PMF (Plasma Melting Facility), was used as the generation data of each nuclide to be applied to assessment of internal exposure. The concentration of each nuclide is shown in Table 2.

Table 2. Radionuclides Concentration of Radioactive Aerosols Collected from PMF

Radionuclides	Concentration(MBq)
^{54}Mn	0.362
^{59}Fe	0.181
^{58}Co	0.0603
^{60}Co	3.44
^{134}Cs	0.362

2.1.4 Particle size of the Radioactive Aerosol. The quantity of aerosols, collected in the melting process conducted by the Kozloduy PMF (Plasma Melting Facility), was not measured by particle size. Accordingly, the aerosol quantity data by particle size in the melting process (Figure 1) conducted in other studies was used as the input data for the BiDAS Code

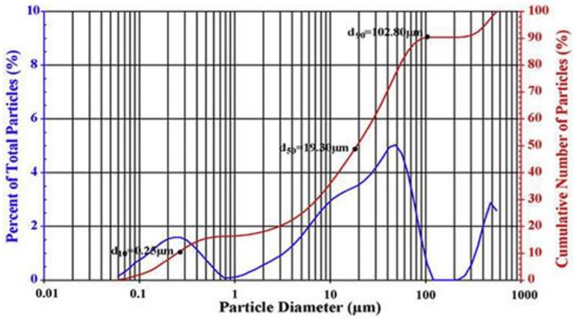

Fig. 1. Particle Size Distribution of EAF (Electric Arc Furnace).

3. Conclusion

The committed effective dose of workers was assessed using the BiDAS Code, and the results are as follows. 1.18×10^{-3} for ^{54}Mn, 4.03×10^{-4} for ^{59}Fe, 5.31×10^{-4} for ^{58}Co, 7.02×10^{-2} for ^{60}Co, and 5.16×10^{-3}mSv for ^{134}Cs.

It is about 0.0016% of Korea's annual maximum permissible dose of 50mSv, and it is about 0.39% of the 5-year average of 20mSv. These figures can be said to be insignificant compared to the annual permissible dose. There is no concern about overexposure due to radioactive aerosols generated in the melting process.

In addition, in the assessment of the internal exposure by nuclide and particle size to understand the difference in the committed effective dose (CED) by particle size, it accounted for 58.5% of the total dose at 0.1um or less and 25% at 3um or more in case of ^{134}Cs. In case of other nuclides excluding ^{134}Cs, it accounted for 76.5% of the total dose at 0.1um or less.

REFERENCES

[1] KAERI, "A State-of-the Art on the Dismantling Techniques for the KRR-1 & 2 Decommissioning", KAERI/AR-609/2001.

[2] Annotation of the Investment Proposal-Activities and Technologies, Environmental Impact Assessment Report for the Decommissioning of Units 1 to 4 at Kozloduy Nuclear Power Plant, P16Del109Rev02_EIA_R (2013).

[3] X. Lin, Z. Peng, J. Yan, Z. Li, J. Yang Hwang, Y. Zhang, G. Li, T. Jiang, "Pyrometallurgical Recycling of Electric Arc Furnace Dust", Journal of Cleaner Production 149 1079-1100 (2010).