A Study on the Assessment of Internal Exposure Effect by Radioactive Aerosol Generated During Melting Facility of NPPs Using Internal Exposure Code

Sun Il Kim, Hak Yun Lee, and Jong Soon Song*
Chosun University, 309, Pilmun-daero, Dong-gu, Gwangju, Republic of Korea
*jssong@chosun.ac.kr

1. Introduction

The radioactive aerosols, which are generated during the decommissioning of a nuclear power plant, are inhaled by workers and deposited in the respiratory organs and other vital organs in their body and cause internal exposure. Also, as internal exposure is difficult to measure directly unlike external exposure, it is necessary to assess internal exposure in advance, and derive the optimal working hours and select working conditions for preventing workers' overexposure caused by radioactive aerosols.

2. Assessment factors during internal exposure assessment

2.1 Quantity of each nuclide

As the quantity of each nuclide is directly related to workers' intake as well as respiratory rate, it must be determined first before conducting internal exposure assessment. In this study, the nuclide data, collected in the process of melting the structures decommissioned by the Kozloduy NPP, was used as the data on the quantity of nuclides. This paper applied the quantity of ^{60}Co, the representative considered nuclide, and actually it is the most considered nuclide or the nuclide to be decontaminated during the decommissioning of a nuclear power plant. The quantity of ^{60}Co is 3.44MBq.

2.2 Particle size (AMAD)

The distribution of the particle sizes of the radioactive aerosols is an important factor that affects the internal exposure dose due to workers inhalation. As the fine particles of radioactive aerosol stay longer inside the body than the relatively bigger particles of radioactive aerosols, they cause long-term exposure in the whole body or organs. Like this, as the effects on the human body vary depending on particle sizes, to assess the internal irradiation dose due to the decommissioning site workers inhalation of aerosols, the distribution of particle sizes must be determined. As this study failed to secure measurement data of radioactive aerosols, however, 5μm, recommended by ICRP, was used.

3. Input Data computation

To enter the data on the quantity of each nuclide, mentioned in Section 2, in the BiDAS code, a series of conversion processes are necessary. This section described the computation process necessary for applying the data secured by the author to the BiDAS computer code, and the assessment interval was daily, and one year of internal exposure dose was assessed.

3.1 Using the concentration and respiratory rate to assess intake

Workers internal radioactivity level can be derived from the intake yield and intake. The period from the intake start date to the intake end date is expressed as T, and M(t), the measurement value at t, a certain number of days from the intake start date, will be expressed as shown in the following formula. m(u) refers to the intake yield at u, a certain time after intake, and I refers to the total intake from the intake start date to the intake end date.

$$M(t) = \frac{I}{T}\int_{t-T}^{t} m(u)du \qquad (1)$$

As the Kozloduy PMF facility is operated for 40 weeks a year, computation was done assuming 280 days (40 weeks), and the level of radioactivity in a total of 4 organs, i.e. the body, the lung, urine and feces, were derived 1,120 times for Type M and S respectively, i.e. a total of 2,240 times.

4. Internal exposure assessment

The results of internal exposure assessment are 0.0341 mSv and 0.0909 mSv respectively. The difference in committed effective dose for Type M and Type S is 0.0568 mSv, about 2.70 times different. It is believed to be because as the particles are dissolved faster in the respiratory organ, the time they stay in the lung is reduced, and the particles move fast to the blood, whereas as the particles are dissolved more slowly, they stay longer in the lung and thus the exposure radiation dose of the lung increases.

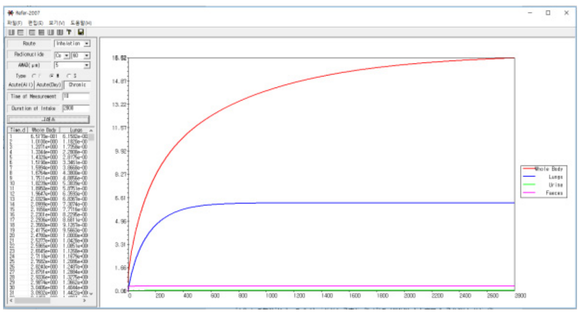

Fig.1. Fraction of intake of ^{60}Co.

5. Conclusion

The BiDAS computer code was used to assess the committed effective dose. Workers' committed effective dose due to ^{60}Co was 0.0341 mSv for Type M, and 0.0909 mSv for Type S. Compared to the annual permissible dose of Korea, the committed effective dose was insignificant 0.17% and 0.45% respectively. So it was concluded that when metals are melted, the overexposure from the viewpoint of internal exposure due to radioactive aerosols is not to be feared.

ACKNOWLEDGEMENT

This work was supported by a Nuclear Technology & Development Program of the National Research Foundation of Korea (NRF) grant funded by the Ministry of Science and ICT (MSIT) (Grant No. NRF-2017M2A8A4018598)

REFERENCES

[1] EWN, "Experience from Greifswald NPP Decommissioning in Germany", EWN Final Report, P5cDel03Rev02-EIA-R-Chapter11(2013).

[2] ICRP, "Individual Monitoring for Internal Exposure of Workers (Preface and glossary missing), Publication 78, Ann. ICRP 27(1997).

[3] EWN, "Environmental Impact Assessment Report for the Facility for Treatment and Conditioning of Radioactive Waste with a High Volume Reduction Factor at Kozloduy Nuclear Power Plant", EWN Final Report, P5Cd03Rev.02-EIA-R-Chapter 4(2013).