Exposure Dose Assessment on the Fire originated in the Temporary Storage Facility for LILW Management

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1. Introduction

In Korea, the low and intermediate level wastes (LILW) generated from the operation of NPPs have been gradually increased since 1978 because of the absence of the repository for the disposal of LILW [1]. In 2005, fortunately, the Gyeongju city was selected by the resident's vote in four competitive provinces for the LILW disposal facility. The repository for the disposal of LILW will be operated in end of 2009. In opposition to a variety of the researches on the disposal of the LILW, the risk assessment originated in the temporary storage facility for LILW has scarcely been conducted. Especially, the details in regard of the safety analysis on the temporary storage facility have not been considered in the preliminary and final safety analysis report. According to the consequence of these situations, the number of the researches on the arbitrary accidents occurring in the temporary storage facility has been urgently required.

2. EXPOSURE DOSE ASSESSMENT MEDELING

The arbitrary accidents concerned to LILW management in the temporary storage facility could be derived by the master logic diagram (MLD) method, which is based on the fault tree analysis (FTA) but without the formal mathematical properties. The dropping of the drums and fire were developed by the main accidents originated in the temporary storage facility for LILW [2]. In this study we only considered the exposure effect resulted from the fire originated in the temporary storage facility for LILW. And then, the waste stream considered for the dose evaluation was four kinds of that: DAW, evaporator bottom, spent resin, and spent filter. Furthermore, dose evaluation was only conducted with respect to the waste stream packaged in the DOT-17H (200 L) that is the representative drum used in NPPs. The drums, which were produced in January of every year at the Kori nuclear power plant (NPP) between 1981 and 2005, were used to evaluate the amount of radionuclides released by the fire. The source terms for the dose evaluation were considered 13 radionuclides: ^{3}H, ^{14}C, ^{55}Fe, ^{58}Co, ^{60}Co, ^{59}Ni, ^{63}Ni, ^{90}Sr, ^{94}Nb, ^{99}Tc, ^{129}I, ^{137}Cs, and ^{144}Ce, which were indicated in the Notice 2008-65 legislated by the ministry of education, science and technology [3].

2.1 Radionuclide inventory caused by the fire

In order to evaluate the amount of radionuclides released by the fire, the release rates with respect to the type of wastes and radionuclides were considered. Especially, the flammability multiplier factor owing to the fire was derived by the following equation:

$$f_F = 20^{-IFL} \quad (1)$$

where f_F indicates the flammability multiplier factor and IFL denotes the flammability subindex [4].

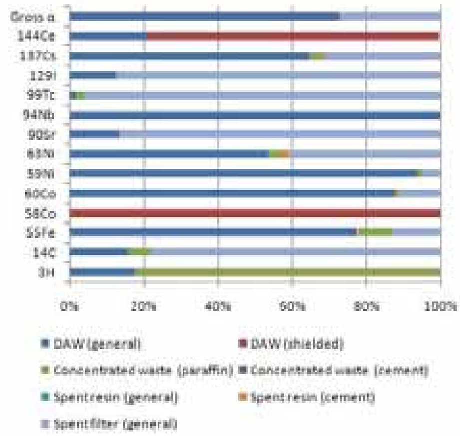

Figure 1. The relative presence ratio on the radionuclides with respect to the waste streams considering the release rate by the fire

2.2 Derivation of the atmospheric relative concentraion

In this study the atmospheric relative concentration (χ/Q) was calculated by the U.S. NRC' computer program named PAVAN [5]. All of meteorological data were collected at the point of 10-meter height in the meteorological observation tower of Kori NPP. For more accurate calculation, the numbers of meteorological data were about 100,000 and these data were measured between January 1, 2005 and December 31, 2007. The meteorological monitoring program for the NPP indicated in the U.S. NRC regulatory guide 1.23 was used for the calculations of the joint frequency distribution (JFD) of wind direction and wind speed by atmospheric stability [6]. The χ/Q-frequency values normalized with respect to all time for worker and public were showed in the Figure 2. For final exposure dose assessment, we adapted the χ/Q corresponding to the 50 percentile for worker and public, indicating to 4.820E-3 sec/m^3 and 2.924E-5 sec/m^3 respectively.

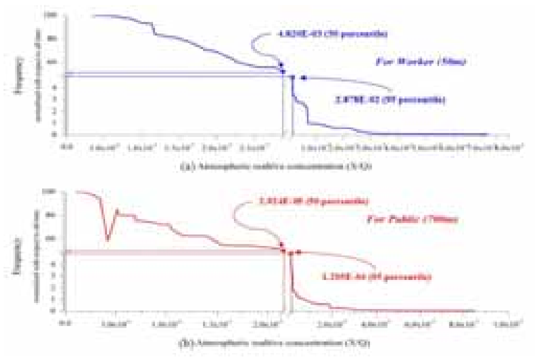

Figure 2. The χ/Q-frequency values normalized with respect to all time (a) worker, (b) public

2.3. Exposure dose assessment modeling

The exposure effects resulted from release of radioactive materials related to the fire in the temporary storage facility for LILW can be divided with the external exposure by radioactive plume and internal exposure caused by breathing [7].

$$D_p = \sum_i \left(\frac{1}{3600}\right)\left(\frac{\chi}{Q}\right)_i Q_i DFP_i \quad (2)$$

$$D_b = \sum_i \left(\frac{\chi}{Q}\right)_i Q_i Br_i DFH_i \quad (3)$$

where the D_p is the external exposure dose (mSv), the i is the radionuclides, $(\chi/Q)_i$ is the atmospheric relative concentration (sec/m^3), the Q_i is the amount of release with respect to each radionuclide (Bq), the DFP_i is the dose conversion factor for the external exposure (mSv/hr per Bq/m^3), the D_b is the internal exposure dose (mSv), the Br_i is the breathing rate (m^3/sec), and the DFH_i is the dose conversion factor for the internal exposure (mSv/Bq).

For the evaluation of internal exposure, the breathing rate (m^3/sec) described in U.S.NRC regulatory guide 1.8 was considered. The effective doses for worker and public were calculated with respect to the Fire (Fig.3-4).

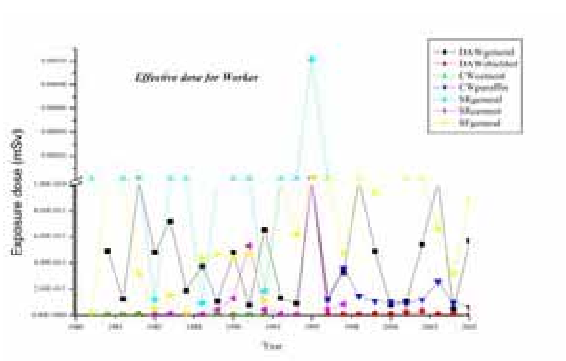

Figure 3. The effective dose resulted from the fire for worker

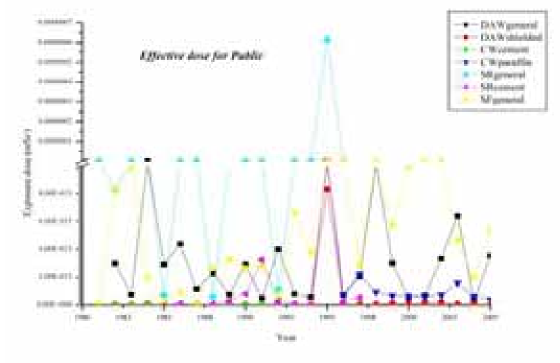

Figure 4. The effective dose resulted from the fire for public

Especially, after considering the real conditions with respect to managing the LILW at the temporary storage facility, the number of damaged drums by the fire was considered 40 drums relative to each waste stream. The effective doses resulted from the fire were in the range of between 6.18E-17 and 1.01E-4 mSv for worker, 3.77E-19 to 6.15E-7 mSv for public.

3. CONCLUSION

To conduct the exposure dose assessment on the fire originated in the temporary storage facility, a variety of parameters were considered. Especially, the exposure doses caused by the fire considered in this study did not exceed the regulatory dose limits with respect to the arbitrary accidents originated in the temporary storage facility for LILW management.

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