Consideration Factors for Public Dose Assessment During Decommissioning of Nuclear Power Plant

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1. Introduction

Kori unit 1, the Korean oldest commercial NPP, was permanently shut down in 2017 and decommissioning activities will be conducted five years later. Also the Wolsong unit 1 is expected to be in decommissioning stage in the near future. KHNP, the licensee, should arrange the full-scale stage plan in order to safely carry out the power plant decommissioning.

A final decommissioning plan (FDP) should be submitted to the regulator with incorporating the results of the public hearings in order to get approval for decommissioning. The safety assessment is one of essential part of the FDP because it describes how exposures of the public are kept as low as reasonably achievable (ALARA) below the relevant limits during decommissioning [1]. However, there is no useful assessment methodology for the public dose assessment in decommissioning stage.

For this sake, we have carried out the review IAEA safety assessment methodology and developed a conceptual diagram that be applicable to the chapter 6. safety assessment part in FDP. Based on this concept, we have analyzed the normal events and abnormal events during the decommissioning, which assessed public dose for each exposure scenario. This paper is to propose considering factors for public dose assessment not only the normal decommissioning activities but also the abnormal events.

2. Considering Factors

Decommissioning stage is different from the operation phase of nuclear facilities in that decommissioning has cutting activities of radioactively contaminated and/or activated components and structures, where radioactive dusts and gas are dispersed into atmosphere.

It is necessary for public dose assessment to estimate the amount of radionuclides released into the atmosphere and the ocean during decommissioning operation. Therefore, it should be assumed in consideration of dismantling activities, residual radioactive inventory, and decommissioning schedule, etc. Fig. 1 shows the conceptual diagram to assess the doses to public in the normal situations and abnormal situations. Each consideration is presented in the Fig.1 as alphabet (a), (b), (c), (d) and described details in the below.

2.1 Amount of Radionuclides Discharged (a)

Two types of waste (gaseous, liquid) are generated and released into atmosphere and ocean according to the dismantling activities. Amount of radionuclides discharged waste are assumed based on the quantity of generating waste and filtration efficiency. The gaseous wastes are only considered in this study.

The amount of gaseous wastes depends on cutting technology, number of cutting pieces, cutting length, etc. Especially, each cutting methods such as plasma arc, thermal cutting, mechanical cutting has respectively different kerf width and dispersion ratio during cutting activities. And the kerf length depends on the type of the container in which the component will be stored. Shapes of components such as piping and ducts also affect the kerf lengths. Therefore these factors need to be considered for the evaluating the amount of gaseous wastes. To calculate the quantity of generating aerosol, the following information is required and total amount of generating wastes (G_{ij}) is simply expressed in the below equation (1) [2].

- G_{ij} of radionuclide i and cutting tool j
- Concentration of radionuclide : C_i (Bq/cm^3 or Bq/cm_2)
- Kerf volume / surface : K_j (cm^3 or cm^2)
- Dispersion ratio of each cutting tool : D_{ij}

$$G_{ij}(Bq) = \sum(C_i \times K_j \times D_{ij}) \quad (1)$$

2.2 Filtration Efficiency (b)

To minimize the radiological hazards, the ventilation systems are installed to prevent the aerosols that are generating from the cutting activities. Also the evaporator systems and resin systems are equipped in the facility to prevent radionuclide release to the ocean. In order to calculate the amount of radioactive material deposited on the filters, the filtration efficiency should be considered.

2.3 Radiological Environment Analysis (c)

If the radionuclide inventory discharged into the environment is calculated, the next step is to assess the public dose that is the same as the existing methodology for the operate phase. Based on the values such as diffusion factor, site characteristics factor, and amount of intake, etc., the public exposure dose can be evaluated.

2.4 Accident Scenario (d)

To draw the potential accident scenario that could occur during the decommissioning activities, the HAZOP process should be performed [2] and it is in progress by an expert group. The typical accidents during decommissioning can be caused by drop, fire, explosion, loss of containment and liquid spill.

The scenario that could lead to the biggest accident is an accident in which all the radioactive material deposited on the filter is released to the atmosphere due to the filter fire. Based on the mentioned factor (b), the amount of radioactive material can be assumed and accident scenario should be conservatively approached to evaluate.

3. Conclusion

In this paper, we reviewed the considerations to assume the radioactive discharge rate. Reasonable assumptions for the sake of safe decommissioning are very important to evaluate the dose of the public. In most cases, for conventional estimation of public exposure dose, the quantity of radionuclides that disperse or migrate over an entire period of decommissioning were assigned to the first year of dismantling work to evaluate public exposure dose [3]. Assuming that all dismantling activities are carried out in one year, we have evaluated the public dose considering the aforementioned factors. And in order to obtain reliable results, actual power plant characteristic data will be applied.

REFERENCES

[1] Nuclear Safety and Security Commission, Regulations of Nuclear Facilities Decommissioning Plan, Notice 2018-10.

[2] Safety Assessment for Decommissioning, IAEA Safety Report Series No.77.

[3] Decommissioning plan of Tokai power station, Japan Atomic Power Company, 2006.

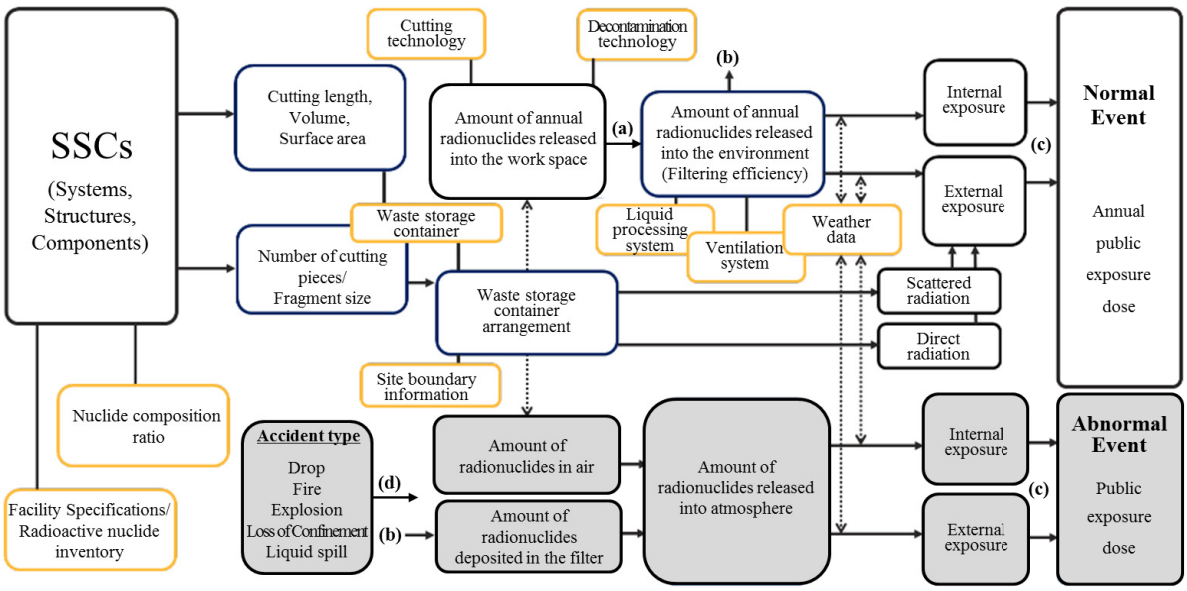

Fig. 1. Conceptual diagram for public dose assessment during decommissioning.