The Radiation Exposure Assessment during Decommissioning

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1. Introduction

In Jun 2017, Kori #1 is permanently shut down after reaching the end of 40-year lifespan. A Korea Hydro & Nuclear Power Co., Ltd as a utility should design a decommissioning plan. Also, all of other nuclear power plants, nuclear fuel cycle facilities and other nuclear facilities are demanded to prepare preliminary and final decommissioning plan. Especially, safety assessment during decommissioning was highlighted for design the decommissioning plan, IAEA established a forum for the sharing and exchange of national information in 2004. In addition, it is important in other situation like on operation or accident [1].

In this research, I performed evaluation of external exposure which consist of building decontamination and equipment dismantling as a part of safety assessment for nuclear fuel cycle facility of KAERI.

2. Safety Assessment of Preliminary Decommissioning Plan

The Nuclear Safety and Security Commission notification 2015-8 consist of 10 sections and provide contents information of preliminary and final decommissioning plan. Section 6 provides a description about safety assessment which has 6 subsections: 1) principles and standards 2) scenario 3) assessment of exposure 4) residual radioactivity 5) abnormal events 6) risk assessment. Also, IAEA SRS No. 45 (IAEA Safety Report Series No.45) which is reference of NSSC notification refers to safety assessment in section 9. In preliminary decommissioning plan, organization should provide radiological characterization, exposure scenario and path, WBS (Work Breakdown Structure). And exposure dose of worker and resident is evaluated using it[2].

In this research, Evaluation of exposure dose consider both situation: (1) normal events (2) abnormal events during the decommissioning of facility. Both normal and abnormal events include external exposure, internal exposure by inhalation or injection of dust and emission to environment during the decontamination and decommissioning. However, this research focuses on external exposure.

The external exposure is shown in man-mSv using UCF (Unit Cost Factor). Results from this research can be adapted to decommissioning plan making which is like man-power and working plan.

3. Results of Safety Assessment

The safety assessment is evaluated depend on physical and radiological inventory data from PIEF (Post Irradiation Examination Facility) of KAERI.

A decontamination activity consists of building decontamination and dismantle equipment, and building decontamination includes wall decontamination and its monitoring. Therefore, external exposure considered both of activities, calculated using following equation (1).

$$ED_{its} = \sum_{its}(Q_{it} \times PF_{it} \times D_l \times E_r) \qquad (1)$$

Where, Ed_{its} is total external exposure dose for worker (man-mSv), Q_{it} is quantities of D&D work item (m^2, m^3, kg), PF_{it} is productivity factor of item (man-hr/unit, UCF(Unit Cost Factor)), D_I is dose rate (mSv/hr), Er is escalation ratio (%)

The radiological characterization is obtained from Radiological Safety Control annual report from KAERI. In this research, radiological data of every rooms cannot investigate due to on operation now. However, one or more data are used in valid sector for conservative evaluation. A man-power is regarded as UCF from experiences of decommissioning of research reactor 1, 2 and the uranium conversion plant (UCP). The man-power for the decommissioning work of the PIEF was calculated as follows.

- Building decontamination
  - Monitoring: 0.5 man-h/m^2
  - Decontamination: 0.8 man-h/m^2
- Equipment dismantling
  - General equipment: 19 man-h/ton
  - Massive equipment: 20 man-h/ton
  - Steel linings: 70.4 man-h/ton
  - Massive reinforced concrete: 5.1 man-h/ton

A decommissioning sequence of PIEF is made by two rules: 1) out to in 2) cold to hot. Each sequence has working plan which is combination of decontamination and dismantling schedule of several rooms. For instance, sequence 2 is combined working plan of several

working zone (7000 zone), and sequence 3 is also combined working plan of intervention zone (8000 zone).

Table 1. External dose evaluation in normal events during decommissioning of PIEF

Sequence	External dose (man-mSv)	
	Building	Equipment
2	6.47	5.18
3	4.47	0.51
4	2.11	0.23
5	2.85	33.95
6	3.75	24.61
7	2.25	0.00
8	0.00	0.00

In table 1, external exposure in sequence 5, 6 are dominant for design the decommissioning plan during whole sequence. In sequence 5 and 6, external exposure was occurred too much due to decontamination works of concrete and steel lining of hot cell and spent fuel pool, it influences increasing the whole dose. A whole exposure dose during decommissioning of PIEF is 86.38 man-mSv. According to this result, man-power and period of decommissioning plan can be set up under a limitation.

For abnormal events, accident to fail air circulation system in working area is being assumed during decontamination and decommissioning. Air circulation system is installed at working area, and additional filtering system also. The accident is assumed that dust collected at filtering system suddenly spread at once due to break down of system. External exposure is evaluated for this accident as modeling a working area by using MCNP. Worker is located the center of working area under the radioactive dust.

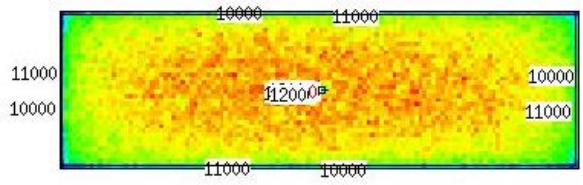

Fig 1. External exposure dose of worker under the abnormal events during decontamination of PIEF

Fig 1. is shown result of distribution of exposure dose by radioactive dust under the air condition by MCNP[3]4. According to MCNP simulation result, worker is contaminated 9.78 x 10^{-2} mSv/hr as a result of abnormal event.

4. Conclusion

In this study, external exposure is performed as a part of safety assessment. According to this research, utility or organization can satisfy dose limitation on regulation as controlling a man-power and working period[4]. For example, man-power and working period is set up 8 man and 1.6 year in sequence 5 and 6 which has most severe condition during decommissioning, exposure dose satisfy under the 20 mSv/year on NSSC notification.

The results of this research will also contribute to design the preliminary and final decommissioning plan of nuclear fuel cycle facilities which don't occur activation.

5. Acknowledgements

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