External Dose Assessment During Dismantling Biological Shield of Kori-unit 1

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INTRODUCTION

The decommissioning nuclear power plant occurs due to aging or other reasons. Accordingly, dose evaluation for the dismantling worker is required, and an additional dose may arise due to the accident of the worker during dismantling. Bioshield, one of the structures of nuclear power plants, has a complex structure and working environment for dismantling concrete. Therefore, the dose evaluation by using software is required to evaluate the external exposure.

VISIPLAN is a tool developed by SCK · CEN, which uses internet technology to calculate doses and transmits the results of 3D data, allowing users to calculate doses in 3D scenarios. The method is used in the dose assessment to take into consideration the position of the worker, the duration of the work, and hence the geometrical structure and source distribution changes in the 3D computer simulation of the workplace, based on the point-kernel calculations [1].

In this study, the source and the scenario were assumed and preliminarily evaluated the dose of the Bioshield dismantling worker of the PWR type reactor using VISIPLAN.

Input parameter setting

For the external dose evaluation, the geometrical structure was assumed to be a cylinder in figure 1.

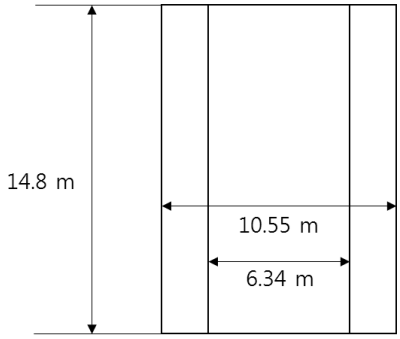

Fig 1. Geometrical structure of Bioshield

Concentrations of nuclides for dose evaluation were calculated using MCNP, and ^{60}Co, ^{152}Eu and ^{154}Eu which are a major part of the dose, were used as the target nuclide as shown in table I.

TABLE I. Kori unit 1 bioshield average radioactivity

Distance (cm)	^{60}Co (Bq/g)	^{152}Eu (Bq/g)	^{154}Eu (Bq/g)
291.5	4.E+03	2.E+01	4.E-01
344.5	2.E+02	1.E+00	2.E-02
397.5	4.E-04	3.E-06	5.E-08
450.5	6.E-07	5.E-09	8.E-11
503.5	4.E-08	3.E-10	5.E-12

Concentrations of nuclides were averaged and calculated as the value within each source. For external exposure calculations, VISIPLAN is added up the dose of each point, which called "point kernel" integration [2]. The uncertainty of the working time was set at 5%, and the statistical error limit was set at 5%.

Dismantling Scenarios

The dismantling worker moves to a certain dismantling scenario. Depending on this scenario, the exposure level of the worker can be greatly changed. It was assumed that four workers perform the dismantling work in the following scenarios. In the event of an accident, the dose of the injured worker and the rescuing rescuer were evaluated. The dismantling and accident scenarios were based on the dismantling procedure of the KRR 1&2 and industrial accidents in Korea [3,4]. Figure 2 shows schematically the decommissioning operation.

For the dose assessment, the positions of the workers in the normal scenario and the accident scenario was defined as shown below and figure 2.

Normal scenario
- Preparation: 2 hours (1m) 4 workers
- Drilling: 1 hour (0.1m) 2 workers
- Diamond wire saw operation: 1 hour (0.5m) 2 workers
- Concrete salvage: 20 min.(0.1m) 2 workers

Accident scenarios 1(Concrete slab accident at 8 m height)
- Concrete block (1·1·1 m^3) slab to worker
- Movement of rescue crew: 4 min.
- First aid: 10 min.
- Transportation: center crane rides, 4 min.

Accident scenarios 2(Falling accident at 8 m height)
- Worker falling during work (8 -> 7 m)
- Movement of rescue crew: 6 min.

- First aid: 10 min.
- Transportation: center crane rides, 6 min.

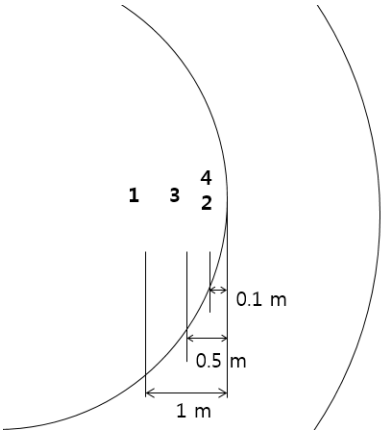

Fig 2. Location of dismantling worker in each scenario (1. Preparation, 2. Drilling, 3. Diamond wire saw operation 4. Concrete salvage)

In both accidents, the worker was working in an area 1 m away from the concrete wall, and the rescuer descended on the central crane after the accident to perform first aid and to rescue the injured worker.

RESULTS

The dose rate around Bioshield is shown in Figure 4 and the effective dose for during normal operation is shown in table Ⅱ. In the Bioshield dismantling process, heights above 630 cm does not exceed the worker dose limit within the normal working time (2,000 hours per year) without any special measures.

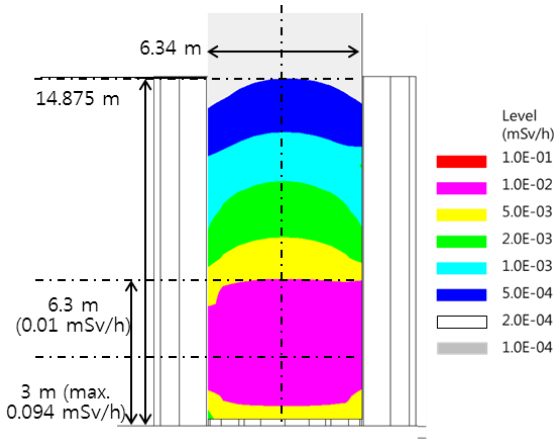

Fig 3. The dose rate of internal space of reactor from radioactive concrete

TABLE Ⅱ. Dose assessment results for working scenarios according to height

Scenario	Collect. Dose (man. mSv)	Maxim. Indiv. Dose (mSv)
300 cm	3.10E-01	8.00E-02
800 cm	1.10E-01	4.40E-02
1300 cm	8.20E-03	2.10E-03

The maximum exposure rate is 18.6 mSv per 600 hours of operation per year, which is rated as less than the worker dose limit with a conservative standpoint.

The effective dose for during accidents is shown in table Ⅲ.

TABLE Ⅲ. Dose received to worker and rescuer during an accident

Type	Worker (μSv)	Rescuer (μSv)
Concrete slab	1.1	0.96
Falling	1.8	1.3

In case of accident, the dose by falling is 63% for worker and 35% for rescuer higher than the dose by concrete slab. Dose rate at each scenario is compared at table Ⅳ. During rescue in concrete slab accident is 5% higher than normal operation, and dose rate during rescue in falling accident 74% higher.

TABLE Ⅳ. Dose rate at each scenario

Scenario	Dose rate(mSv/h)
Normal scenario	3.5E-03
Concrete slab	3.7E-03
Falling	6.1E-03

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