

# Assessment of Radiation Dose Rates for Workspace of Pressurizer in Nuclear Power Plant

Ju Young Kim · Ji Woo Kim · Dae Ho Lee · Kwang Pyo Kim\*  
Kyung Hee University

ALhPS



Kyung Hee University

## INTRODUCTION

### Maintenance worker exposure during overhaul period

- Approximately 80% of the total radiation dose to workers in nuclear power plants occurs during overhaul period.
- During the overhaul period, the pressurizer(PRZ) maintenance is one of the works performed.
- The maintenance workers can be exposed to high-energy gamma radiation from the CRUD(Chalk River Unidentified Deposit) deposited inside the PRZ.

### Necessity of assessment of dose rates for workspace of PRZ

- In particular, some maintenance on PRZ is likely to be performed in the vicinity of the CRUD deposited in the lower part of the PRZ.
- As a result, maintenance workers of the PRZ can be exposed to relatively high radiation dose from the gamma ray emitted from the CRUD.
- Therefore, prior to performing work on the PRZ, the radiation dose should be assessed to determine the level of worker exposure.

## OBJECTIVE

### ❖ Assessment of radiation dose rates for workspace of pressurizer in nuclear power plant

- MCNP simulation of the pressurizer
- Assessment of the radiation dose rates in workspace

## MATERIALS & METHODS

### Simulation of the PRZ using computer code

- The PRZ of APR1400, the most recent model of domestic nuclear power plant, was simulated using the MCNP6 computer code.
- The APR1400 design control documents (DCD) and safety analysis report (SAR) were analyzed to simulate geometry and source term of the PRZ.

#### ■ Simulation of geometric structure & source term

- For the geometric structure, PRZ's surge line, lower head, upper head, and the PRZ body shell were simulated.
- For the source term, the CRUD(Chalk River Unidentified Deposit) deposition area of the surge line and lower head of the PRZ was simulated.
- To set the gamma ray emissions per unit area from the CRUD, specific activities of the six nuclides of the CRUD and the equilibrium thickness of the deposited CRUD were considered for each CRUD deposition area.

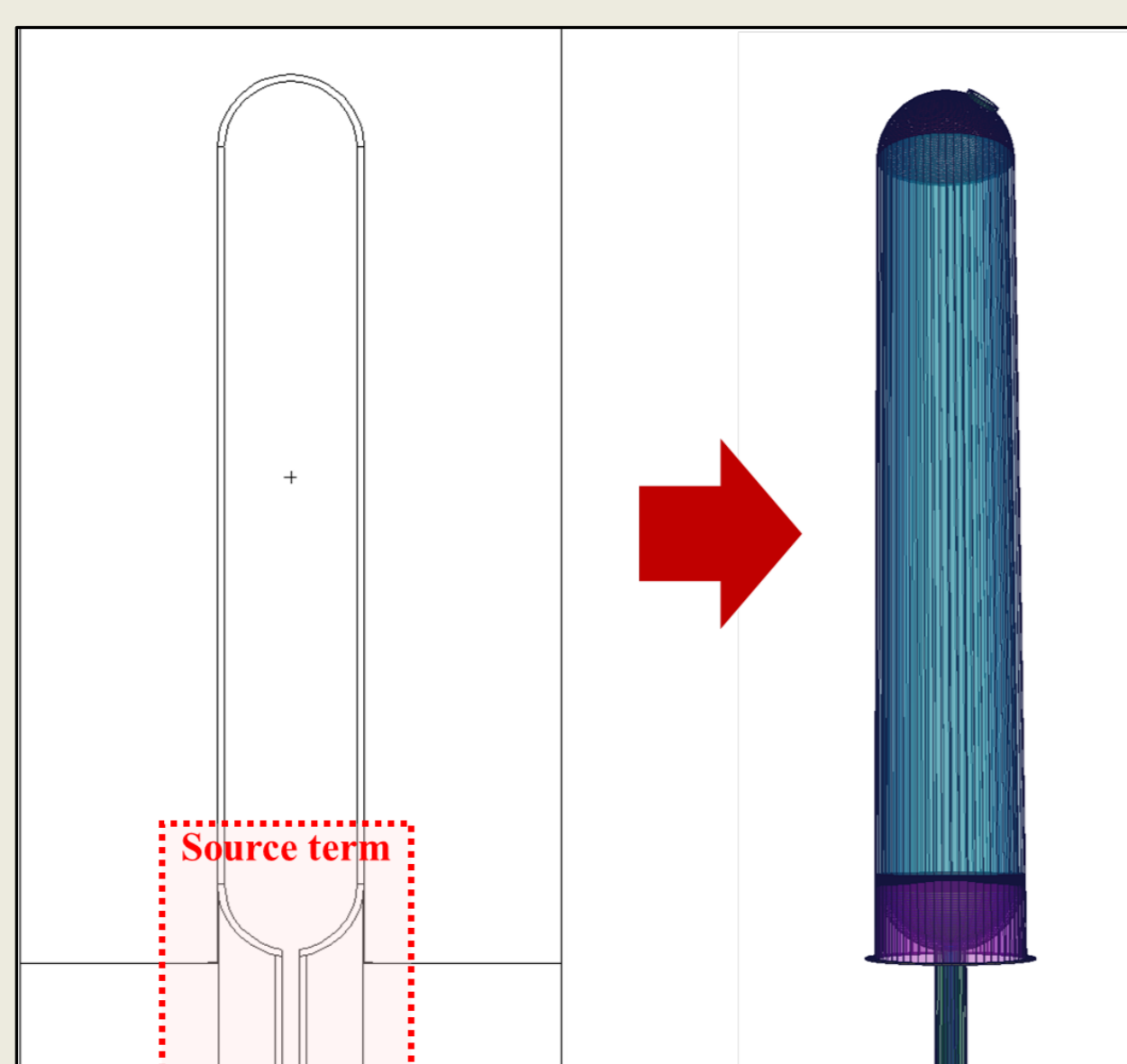


Fig. 1. Geometric structure and source term of simulated pressurizer

### Assessment of dose rates for workspace of PRZ

- For the assessment of dose rates in the workspace, mesh tally function of MCNP6 utilized, and the 10 m × 10 m workspace outside the PRZ was divided into a grid with 50 cm spacing to evaluate dose rates at each point.
- The radioactivity of the CRUD utilized in the dose rate assessment was derived from the specific activities by each nuclide of CRUD.

## RESULTS & DISCUSSION

### Results of simulation of the PRZ

- As a result of the simulation, the radiation dose rates due to the CRUD deposited inside the PRZ were higher in the lower part.
- Also, the center of the PRZ showed a relatively higher radiation dose rates than the periphery.
- This is because the equilibrium thickness of the CRUD deposited in the surge line is about twice that of the CRUD deposited in the lower head, leading to a higher radiation dose rates in the center of the PRZ.

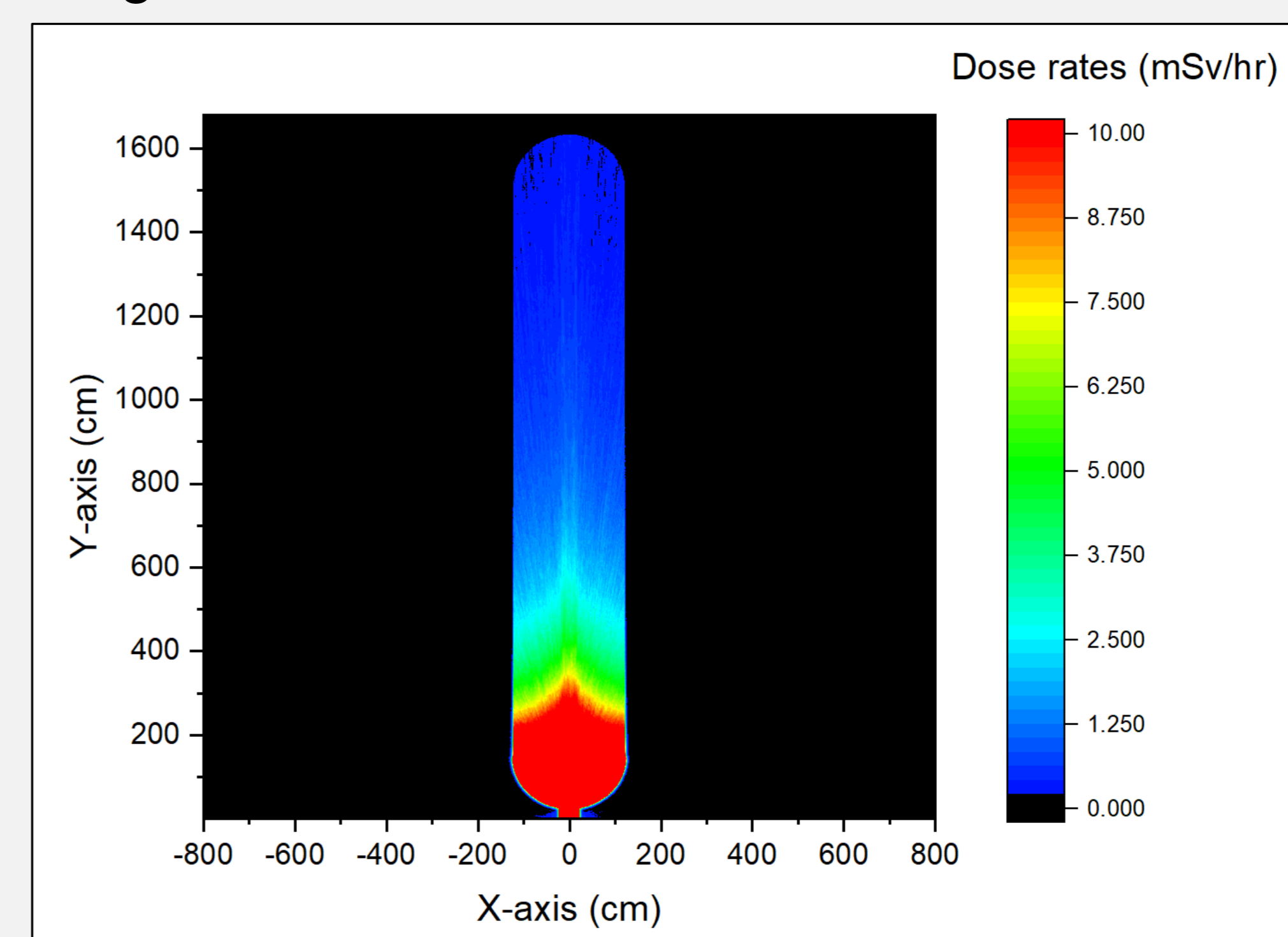


Fig. 2. Radiation field inside the pressurizer

### Results of assessment of dose rates for workspace

- As a result of the assessment, the dose rates ranged from about  $8.06 \times 10^{-4}$  mSv·hr<sup>-1</sup> to  $1.78 \times 10^{-2}$  mSv·hr<sup>-1</sup> for the entire workspace.
- The radioactivity of the source term set in this study was derived based on the specific activity presented in the APR1400 DCD, which is conservative value evaluated using conservative factors.
- Therefore, the results of the dose rate assessment of the workspace around the PRZ are also considered to be somewhat conservative.

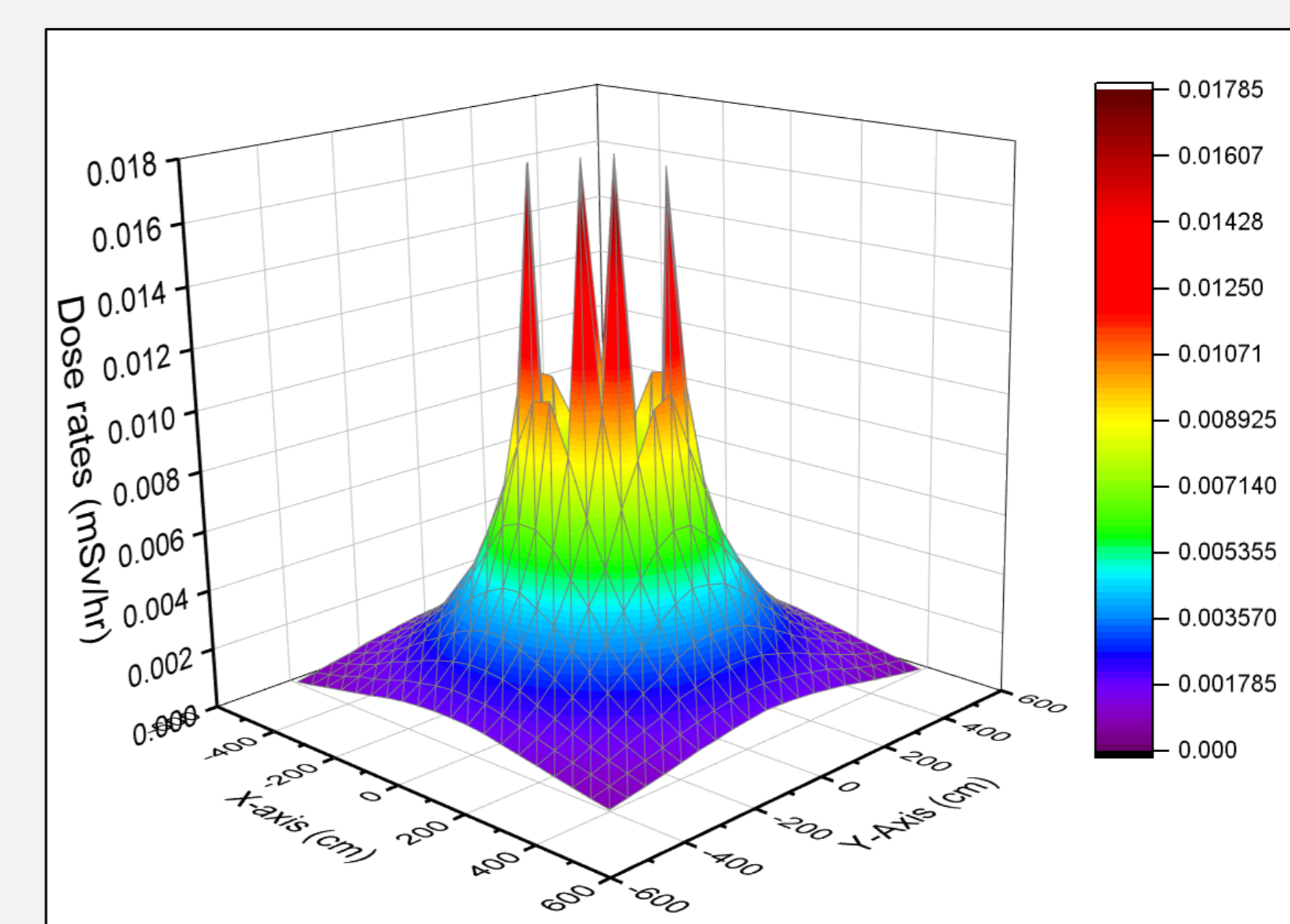


Fig. 3. Radiation dose rates of the workspace

## CONCLUSION

- In this study, a radiation dose rate assessment was conducted for the workspace around the pressurizer in the nuclear power plant.
- The results of the workspace radiation dose rate evaluation showed that the radiation dose rates ranged from  $8.06 \times 10^{-4}$  to  $1.78 \times 10^{-2}$  mSv·hr<sup>-1</sup> for the entire workspace.
- The results of this study can be used as a basis for the dose assessment of pressurizer maintenance workers during overhaul period.

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