An approach to assessment of occupational exposure dose to workers for decommissioning of nuclear facilities

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1. Introduction

In general, decommissioning is under the hazardous environments with high radioactivity and high difficulty. These factors enable workers to make human errors so that exposure dose to workers increases during decommissioning.

Decommissioning of nuclear facilities has to be accomplished by assuring the safety of workers. So, it is necessary that before decommissioning, the exposure dose from human errors has to be analyzed and assessed under the principle of ALARA (as low as reasonably achievable). Furthermore, to improve the proficiency of decommissioning environments, method and system need to be developed.

2. Methodology

2.1 3D mapping of decommissioning environments

To simulate several scenarios of decommissioning, testing environments were designed on a virtual reality. A lot of scenarios were developed in 3D virtual environments to evaluate through simulation.

Fig.1 shows that a reactor was mapped as 3D data. The raw data of dose distribution can be gained from MCNP (Monte Carlo N-Particle Transport) code.

Fig. 1. 3D mapping of decommissioning environments.

2.2 Method of exposure dose assessment

Safety assessment can be accomplished with dose distribution and exposure dose from human errors. The dose distribution means the radioactivity of working environments. The exposure dose from human errors means the additional radioactivity generated from several errors by workers.

The exposure dose from human errors mainly consists of physical human errors, procedure human errors, and operation human errors. The physical human errors mean falling and dropping accidents of a worker during working of a high place and stairs. The procedure of human errors means accidents from not keeping the procedure of a decommissioning scenario. And the operation human errors mean accidents in handling hands-on equipment and remote equipment.

Fig. 2. Measurement of exposure dose.

2.3 Measurement of exposure dose

The measurement starts when a virtual worker collides with dose distribution in virtual environment as shown in Fig. 2. When a worker moves in virtual decommissioning environments, a human model enters into the workplace surrounding dose distribution. At this time, human model collide multiple virtual radiation in virtual environments, the maximum radioactivity can be measured at same position and time and finally the cumulated exposure dose to a worker can be gained.

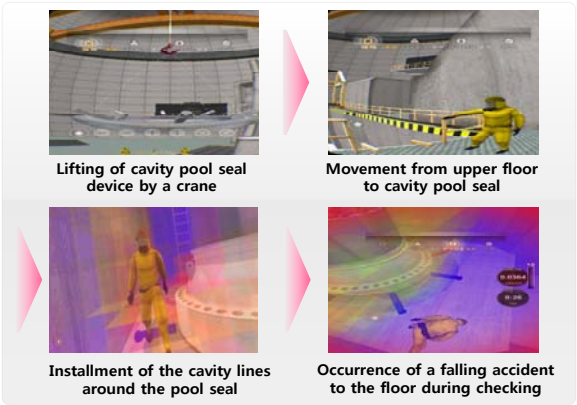

Fig. 3. Performance test of exposure dose assessment.

2.4 Performance test

The assumption on testing of system is that the worker's falling accident rises during installation of cavity pool seal. Once a subject puts the HMD (Head

Mounted Display) on his head, he can look at the cavity pool seal lifted by a crane. The subject starts to go down from the upper floor to the below cavity pool, the other subject supports moving of the one subject. The other subject plays a role in supporting the one fallen subject in case of an accident. At this time the working time and radiation exposure of the subject are for the first time measured. During installing and checking of the cavity lines around the cavity pool seal, an accident of the one worker's falling takes place. The other subject observing the moving of the one subject goes down to the accident spot on a ladder and both of them gets to the upper floor. In the end, the accumulated working time and radiation exposure of the subjects are measured and displayed on the HMD in first mode and on the monitoring device in third mode. Fig. 3 presents a series of performance test.

3. Conclusions

To establish the plan of exposure dose to workers during decommissioning of nuclear facilities before decommissioning activities, it is necessary that assessment system is developed.

This system has been successfully developed so that exposure dose to workers could be real-time measured and assessed in virtual decommissioning environments.

It can be concluded that this system could be protected from accidents and enable workers to improve his familiarization about working environments. It is expected that this system can reduce human errors because workers are able to improve the proficiency of hazardous working environments due to virtual training like real decommissioning situations. In the end, the safety during decommissioning of nuclear facilities will be guaranteed under the principle of ALARA.