Assessment of exposure dose to workers in virtual decommissioning environments

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1. Introduction

Decommissioning of nuclear facilities has to be accomplished by assuring the safety of workers because decommissioning activities of nuclear facilities are under high radioactivity and work difficulty. It is necessary that before decommissioning, the radiation exposure dose of workers has to be analyzed and assessed under the principle of ALARA (as low as reasonably achievable) [1]. This paper is intended to suggest the method analyze and assess the exposure dose to workers in virtual decommissioning environments. To simulate a lot of decommissioning scenarios, decommissioning environments were designed in virtual reality. To simulate and assess the exposure dose to workers, human model also was designed in virtual environments. These virtual decommissioning environments made it possible to real-time simulate and assess the exposure dose to workers.

2. Methods and Results

2.1 Algorithm of exposure dose measurement

In virtual decommissioning environments, the exposure dose to workers is measured by performing cube, human mode, and user interface in Unity3D tool as shown in Fig. 1. As seen in Fig. 1, the cube has functions of Value Init, Updating, and OnTrigger. The functions of cube have a role in checking collision of human model and dose distribution. The human model has functions of Value Init, Mode, Get RadioActivity, and Time Check. The functions of human model have a part in measuring exposure dose to workers during duration of working. The user interface has functions 2D Updating, mSv Show, and TimeShow. The functions of user interface play a role in checking frames of program and in calculating the accumulated exposure dose and time.

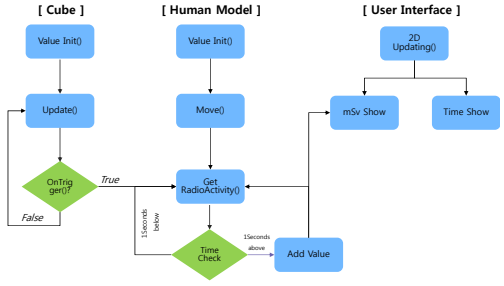

Fig. 1. The algorithm of exposure dose measurement in virtual environments.

2.2 Method of exposure dose assessment

The procedure of exposure dose assessment is shown in Fig. 2. As seen in Fig. 2, execution of MCNP produces the dose distribution. Cubes (50 cm * 50 cm * 50 cm) are built and painted with material colors by values of dose distribution. The built cubes are interrelated with parent cubes. Once a decommissioning scenario starts, time and exposure dose come to be checked when human model moves. When the decommissioning scenario stops, duration of time and accumulated exposure dose are recorded.

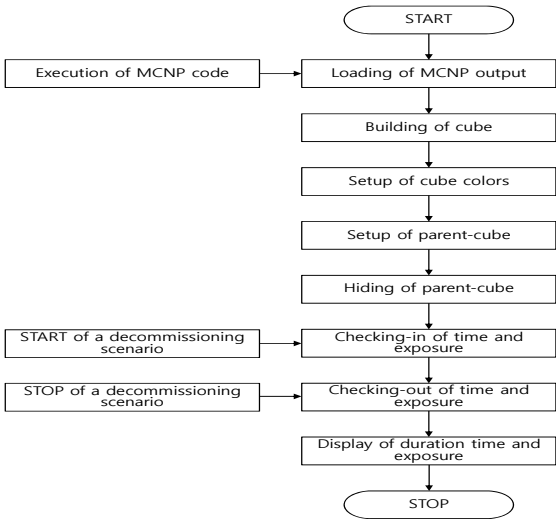

Fig. 2. The procedure of exposure dose assessment.

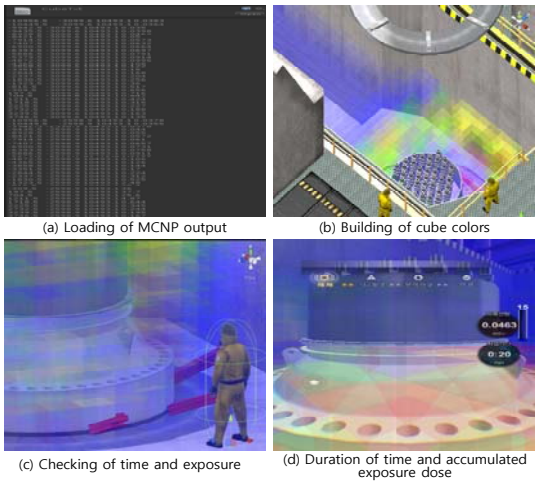

Fig. 3. The feasibility test of exposure dose assessment.

2.3 Test and results

According to the procedure of exposure dose assessment, the feasibility of method was tested as shown in Fig. 3 Changing of worker position within a reactor was selected as a testing scenario of the feasibility. As a worker moves in several directions, exposure dose to the worker could be real-time checked. As seen in Fig. 3, duration of time and accumulated exposure dose could be counted and assessed under the principle of ALARA.

3. Conclusions

This work was to be able to simulate scenarios of decommissioning so that exposure dose to workers could be measured and assessed. To establish the plan of exposure dose to workers during decommissioning of nuclear facilities before decommissioning activities are accomplished, the method of simulation assessment was developed in virtual radiological environments.

But this work was developed as a tool of simulation for single subject mode. Afterwards, the simulation environment for multi-subjects mode will be upgraded by simultaneous modules with networking environments. Then the much more practical method will be developed by changing number of workers and duration of time under any circumstances of decommissioning. It is expected that the method will make it possible to efficiently establish the ALARA plan for decommissioning of nuclear facilities.

REFERENCES

[1] Jeong K.S., Choi B.S., Moon J.K., Hyun D.J., Lee J.H., Kim I.J., Kim G.H., Seo J.S., The digital mock-up system to simulate and evaluate the dismantling scenarios for decommissioning of a NPP, Annals of Nuclear Energy, 69, 238-245, 2014.