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Technical Note

Real-time assessment of exposure dose to workers in radiological environments during decommissioning of nuclear facilities

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ABSTRACT

This objective of this paper is to develop a method to simulate and assess the exposure dose to workers during decommissioning of nuclear facilities. To simulate several scenarios, decommissioning environments were designed using virtual reality. To assess exposure dose to workers, a human model was also developed using virtual reality. The exposure dose was measured and assessed under the principle of ALARA in accordance with radiological environmental change. This method will make it possible to plan for the exposure dose to workers during decommissioning of nuclear facilities.

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).

The legacy methods of exposure dose measurement and assessment had the limitations to modify and simulate the exposure dose to workers prior to practical activities because those should be accomplished without changes of working routes under pre-determined scenarios (SNL, 1996).

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. The virtual environments of decommissioning

To simulate several scenarios of decommissioning, the testing environments were designed on a virtual reality. The development environments were based on digital mock-up of decommissioning (Jeong et al., 2014). Additionally, a lot of scenarios were developed in 3D virtual environments to evaluate through dynamic simulation.

The virtual environments of decommissioning were developed with *Unity3D* and were composed of three design phases. The three design phases consist of 3D mapping, scenario development, and radiation mapping. Fig. 1 shows that a reactor is being mapping as 3D data. Fig. 2 illustrates the scenario development of fulfilling a reactor pool. And Fig. 3 presents radiation mapping of a reactor. The radiation mapping means the amount of dose distribution in a reactor. The raw data of dose distribution can be gained from MCNP (Monte Carlo N-Particle Transport) code.

3. The human model in virtual decommissioning environments

3.1. Configuration of human model

The human model in virtual decommissioning environments has a feature of detecting the amount of collision between the

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0306-4549/

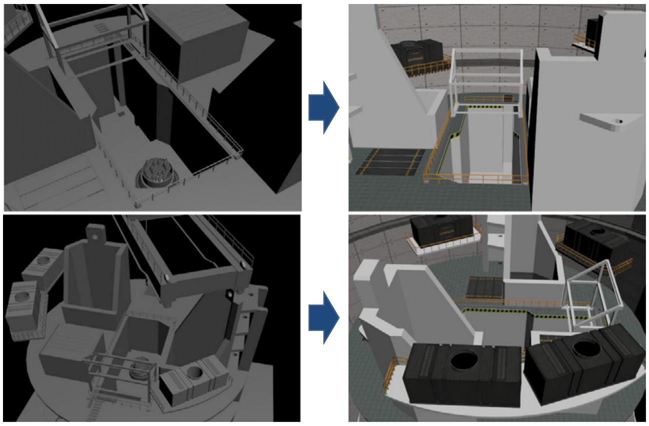

Fig. 1. The 3D mapping environments of a reactor component.

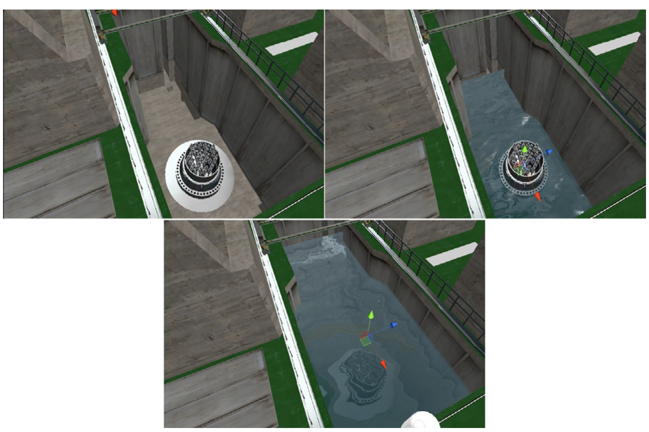

Fig. 2. The 3D mapping environments of a decommissioning scenario.

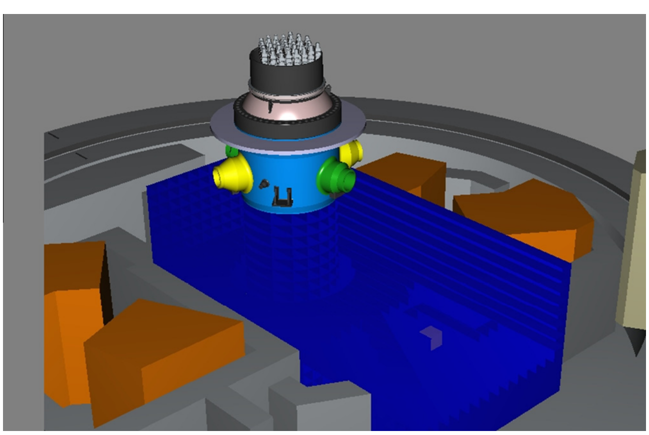

Fig. 3. The 3D radiation mapping environments within a reactor.

human model and exposure dose distribution. The scope of collision between human model and exposure dose distribution is 20 cm in radius and the height of human model is 175 cm as shown in Fig. 4. Fig. 5 displays the specification of human model in *Unity3D* tool.

3.2. Visualizations of exposure dose level

To visualize the level of exposure dose to human model, the levels of exposure dose were classified with colors as presented in

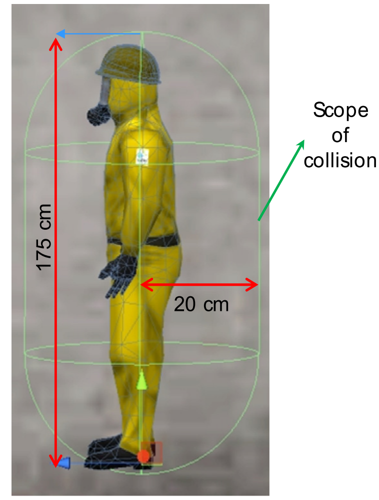

Fig. 4. The human model in virtual environments.

Fig. 5. The specifications of human model in *Unity3D* tool.

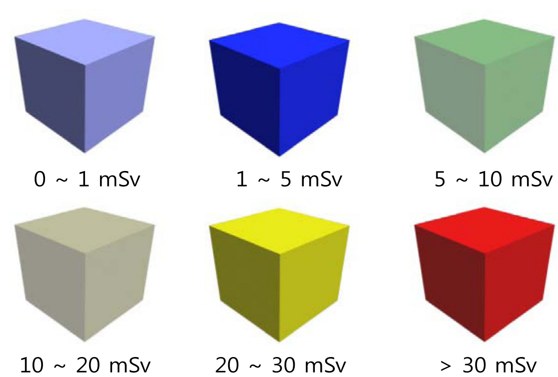

Fig. 6. The classifications of cubes in *Unity3D* tool. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Fig. 6 and developed as cubes in the *Unity3D* tool. The size of cubes is 50 cm. Fig. 7 presents the specifications of a cube in *Unity3D* tool. These classifications of cubes can be modified depending upon radiological situations.