Development of training system to prevent accidents during decommissioning of nuclear facilities

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1. Introduction

Decommissioning workers need familiarization with working environments because working environment is under high radioactivity and work difficulty during decommissioning of nuclear facilities. On-the-job training of decommissioning works could effectively train decommissioning workers but this training approach could consume much costs and poor modifications of scenarios. The efficiency of virtual training system could be much better than that of physical training system [1] [2].

This paper was intended to develop the training system to prevent accidents for decommissioning of nuclear facilities. The requirements for the training system were drawn. The data management modules for the training system were designed. The training system of decommissioning workers was developed on the basis of virtual reality which is flexibly modified.

2. Methods and Results

In this section technical characteristics of the seamless remote cutting system and results of the dismantling process simulation over the reactor pressure vessel are described.

2.1 Requirements of the training system

Items to be required are data handling of structures and equipment, real-time visualization of worker moving route, real-time detection of worker moving route, and real-time monitoring of worker moving route.

Data handling of structures and equipment means that modifications of structures and equipment have to be flexible according as decommissioning scenarios change. Real-time visualization of worker moving route is that worker could see changes of structures and equipment during changes of decommissioning scenarios. Real-time detection of worker moving route is that the system could detect exposure of worker, duration time of worker, error of worker because working situations also change as decommissioning scenarios change. Real-time monitoring of worker moving route shows that the system could monitor worker because the location of worker also changes as decommissioning scenarios change.

2.2 Methods of the training system

The virtual reality system of decommissioning is different from other system in examination of radiation exposure. It is essential to inspire the radiation exposure estimation of worker into the virtual reality system because decommissioning is under high radiation and work difficulty. The radiation exposure of worker could be estimated from space dose distribution multiplied by duration time of worker. The data of the space dose distribution was calculated by the MCNP (Monte Carlo N-Particle transport) code.

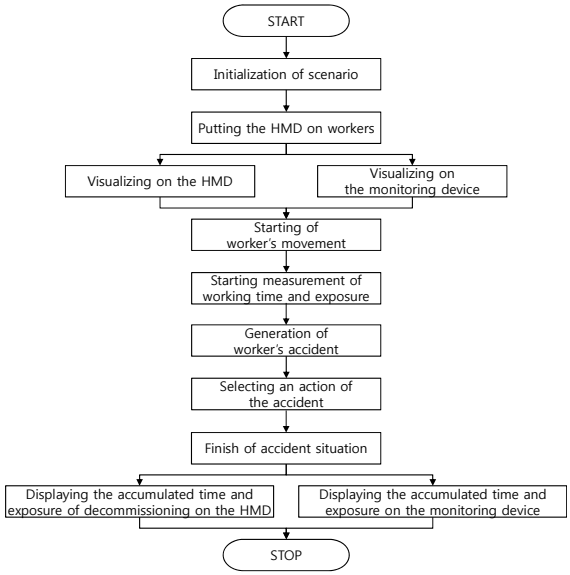

Fig. 1. Flow of the training system.

Fig. 1 presents how to operate the training system. As presented in Fig. 1, the training system is started by initializing the scenario of decommissioning. The subject of the training system then put the HMD (Head Mounted Display) on his head. The visualization of a decommissioning scenario is displayed for the subject through HMD and for the supervisor through the monitoring device of the subject. If the subject starts to move in virtual environment, the working time and radiation exposure of the subject start to be measured. Also, if an accident takes place, alternatives of counter-actions of the accident are provided and choice of the alternatives is made. After finish of the accidental situation, the accumulated working time and radiation

exposure are displayed on the subject's HMD and on the monitoring device of supervisor.

2.3 The performance test of the training system

The assumption on testing of the training system is that the worker's falling accident rises during installation of cavity pool seal. The performance test of the training system is shown in Fig. 2. Once the subject puts the HMD on his head, he can look at the cavity pool seal lifted by a crane. The one subject starts to go down from the upper floor to the below cavity pool, the other subject supports the 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.

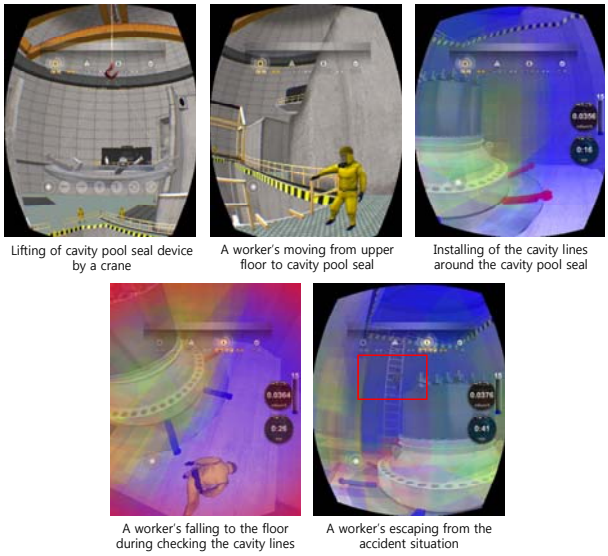

Fig. 2. The performance test of the training system.

3. Conclusions

The performance testing of the training system was satisfactory for the requirements as suggested in Table 1 and proved the systematic interactions of the data management module as proposed in Table 2. The visualization and measurement in the training system were real-time done according as changes of the decommissioning scenario.

It can be concluded that this training system enables the subject to improve his familiarization about working environments and to prevent accidents during decommissioning of nuclear facilities.

4. Acknowledgement

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REFERENCES

[1] Freitas V.G.G., Mol A.C.A., Shirru R., 2014, Virtual reality for operational procedure in radioactive waste deposits, Progress in Nuclear Energy, 71, 225-231.
[2] Mol A.C.A., Aghina M.A.C., Jorge C.A.F., Lapa C.M.F., Couto P. M., 2009, Nuclear plant's virtual simulation for on-line radioactive environment monitoring and dose assessment for personnel, Annals of Nuclear Energy, 36, 1747-1972.