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Development of Public Training System for Emergency Exercise Using Virtual Reality Technology Based on Radioactive Release Accident

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1. Introduction

According to APPRE (Act on Physical Protection and Radiological Emergency) [1], a nuclear power licensee shall conduct a radiological emergency exercise once a year while a small scale nuclear licensee conducts biennially [2]. Presently, an exercise is normally conducted for a day or two days depending on the scale of the exercise. What we have experienced up to date there are several limitations in the radiological emergency exercises such as low public acceptance, poor enthusiasm in the exercise participation, not very attracting exercise scenarios, low efficiency in conducting an exercise, and so on.

In order to overcome the limitations of the present exercising system, we would like to develop a radiological emergency exercise system using VR (virtual reality) technology based on a radioactive release accident. In this paper, we just introduce some basic development methods and event tree based scenario as a beginning stage.

2. Problem Definition

As shown in Fig. 1, a radiological emergency exercise can be classified into 3 steps according to exercise purpose [3]. Among these 3 steps, step 1 is for administration and it is relatively easy to level up for the completeness of an exercise because it is on a success based scenario. While step 2 is for public and strongly related to their random response, therefore, its completeness would be considered to be lower than step 1 and urgently needed to level up as step 1. However, step 3 could be excluded in this problem definition because it deals with long term problem including recovery plan after the accident.

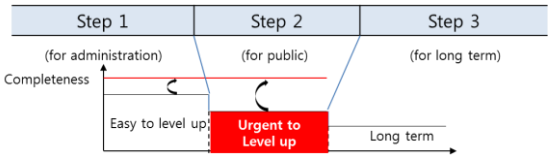

Fig. 1. Status of radiological emergency exercise

The second point is there are several limitations in the present exercise such as ‘limited sources of scenarios’, ‘limited number of public participation’, ‘main focusing on administrative aspect rather than public interest’, ‘participation of multidisciplinary organizations’, ‘difficulties in frequent repetitive exercise’, and so on. Therefore, we are going to introduce a new technology, VR, to solve or alleviate the difficulties in the present exercise as shown in Fig. 2.

The third point is the type of accident for a radiological emergency exercise. One of the important lessons learned from Fukushima accident is that there were no preplanned arrangements for complex disaster resulting in wide spread destruction of transportation, telecommunication, monitoring systems, and so on. So it would be necessary to cope with or consider the radioactive release accident originated in complex disaster as depicted in Fig. 3.

Fig. 2. VR based radiological exercise system

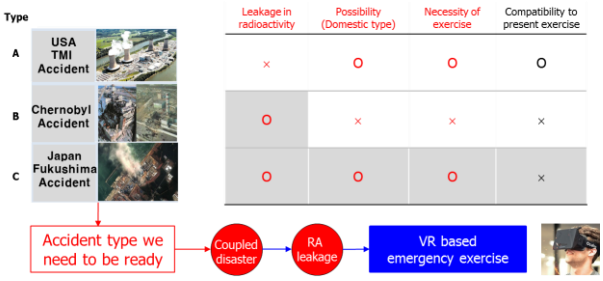

Fig. 3. Accidents with radioactive release

3. Methods

3.1 Development of Emergency Training Scenario based on Event Tree Methodology

VR radiological emergency exercise for the public is could be mainly divided into two emergency Code classifications as ‘Blue and Red’, which are related to mainly sheltering and evacuation, respectively. Each protective action could contain several events or steps, which may be indoor sheltering and related protective actions for the former and temporary collection, moving into safety zone by bus and ITB treatment for the latter. Therefore, there might be really a number of scenarios

resulted from the complex combinations of the steps described above.

Actually it would be impossible to implement the all kind of probable scenarios in VR for emergency exercise. So we are going to use the event tree structure applied in PSA [4] (Probabilistic Safety Analysis) like in Fig. 4 for understanding the scenario spectrum. By using PSA technology, we can consider almost possible scenarios which may occur in a radioactive release accident.

And then among them, we try to decide which scenario would be suitable and effective to emergency exercise. In doing so, some unexpected action or event to occur in real situation could be included. Each event could have its own fault tree as in PSA.

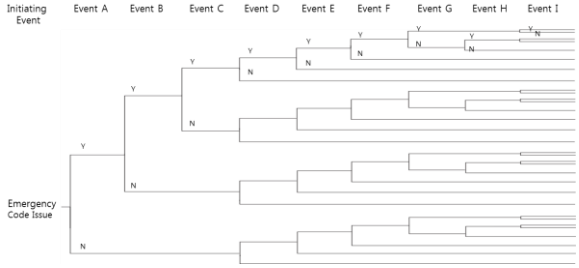

Fig. 4 Event tree structure for emergency training

3.2 Development Strategy

In Korea, there is a national emergency preparedness & response system [5] as an arrangement for radioactive release accident like in Fig. 5.

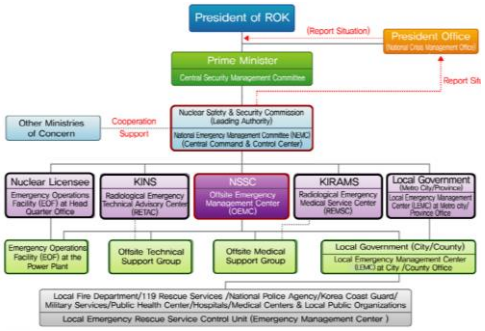

Fig. 5 National emergency preparedness & response system

The organizations related to the system are 'Nuclear Licensee', 'Nuclear Safety & Security Commission (NSSC)', 'Off-site Emergency Management Center (OEMC)', 'Local Government', 'Expert Organizations (KINS, KIRAMS)', 'Related Ministries' and their duties and roles are described in Fig. 6. Actually the VR based radiological emergency exercise system would be supplemental and finally must be designed to be consistent to the national emergency arrangements.

This VR based emergency exercise system would be founded with three areas; APPRE expert's comments, Fukushima accident technical report Vol.3 [6] published by the IAEA and public consultation as in Fig. 7.

The APPRE expert comment would be helpful for us to find out the limitations in present exercise and what should be included in the VR based emergency exercise system.

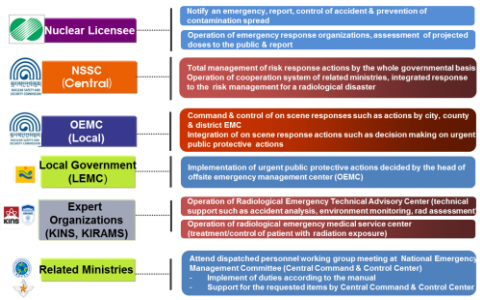

Fig. 6 Duties & roles of nuclear related organizations

Thorough the overview of the IAEA Fukushima accident report, we can expect to understand why Japan's preplanned arrangement would not work properly and select the event to be included in VR based emergency exercise system scenarios shown in Fig. 4. Furthermore, in order to analyze each event, we are going to also refer to IAEA Fukushima accident Vol.3, which would tell us the important events with confusion caused by the incomplete arrangements or complex disaster in doing protective actions such as sheltering, evacuation, ITB (Iodine Thyroid Blocking) and relocation, and so on.

Finally we would refer to public issues related to an emergency exercise and include their private unexpected actions in training scenario because this system would be mainly for them living around NPP.

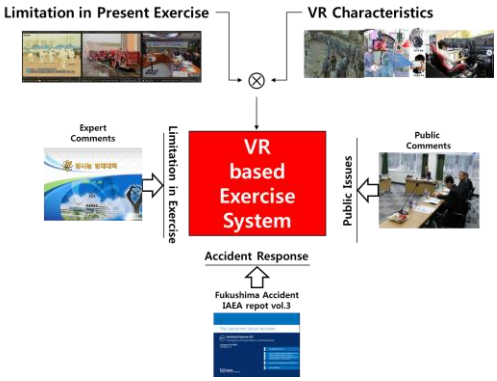

Fig. 7 Major three parts for development of VR based exercise system

4. Summary

After the accident in Fukushima Daiichi NPP, the importance of emergency exercise especially for the public is far more emphasized around the world more and more. However, the human labor focused radiological emergency exercise up to now has many limitations.

In this paper, we have introduced VR based emergency exercise system like in Fig. 8 which could be

expected to overcome some difficulties in the present exercise system. After developing this system properly and by using it, we could even expect to estimate the weak points of the emergency arrangements and strategy we have.

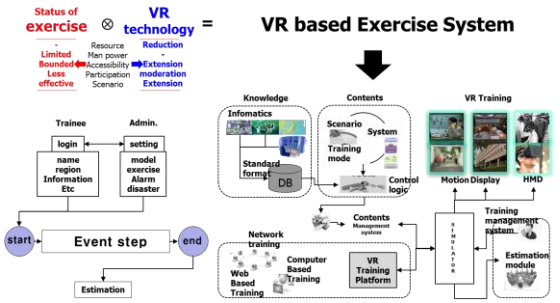

Fig. 8 VR based emergency exercise system structure

REFERENCES

[1] Article 37-3, Act on Physical Protection and Radiological Emergency, No. 11715, Mar. 23, 2013.
[2] 2nd attached form, Article 21-3, Notification of the Act on Physical Protection and Radiological Emergency, 2014-082, NSSC
[3] Oral comment of the expert for APPRE (Act on Physical Protection and Radiological Emergency)
[4] Park & Ha, 'Probabilistic Safety Analysis', brainbook
[5] 3rd attached form, Article 13, Enforcement Regulation of the Act on Physical Protection and Radiological Emergency, No.1108, Nov. 24, 2014.
[6] The Fukushima Daiichi Accident Technical vol. 3/5 Emergency Preparedness and Response, IAEA, 2015.