Development of Scenario Variable Template for Emergency Response Exercise to the Nuclear Accident in Neighboring Countries

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1. Introduction

If a nuclear accident occurs in neighboring countries (e.g. China, Japan, and Taiwan), emergency response measures would be implemented in accordance with guidelines described in the NSSC (Nuclear Safety and Security Commission) manual. To improve the response capability, NSSC conducts the exercise every year. The exercise scenario is a key factor of exercise, but there is no systematic process on the development of scenario. Therefore, it is necessary to establish a exercise system with the scenario model such as variable template.

Prior to developing the exercise scenario for the nuclear disaster in neighboring countries, we carried out a case study to prepare the scenario of the hypothetical accident and exercise for the Hongyanhe nuclear power plant in China [2]. In the previous research, we selected the representative reactor type for each neighboring country and constructed database of source-term release by accident scenario selected for each reactor type [3].

In this study, by a need to establish the prompt and efficient emergency response system, we developed the template for scenario variables applicable to the emergency response exercise for the nuclear accident in neighboring country on the basis of the previous research results mentioned above. Based on the template, we developed an example of the situational scenario for hypothetical nuclear accident in Japan.

2. Methods and Results

For the purpose of setting up basic situations for the case-specific scenario in the exercise design phase, we developed the template for scenario variables such as the date, time, area, scale of the accident occurred, and domestic influence from the accident. It can be possible to prepare a specific exercise situation by appropriately combining settings in the template, and thereafter to establish the final exercise scenario in connection with situation and exercise messages reflecting scenario flow.

More detailed description and guidelines for each variable constituting the template are as follows.

2.1 Components of Scenario Variables

The scenario variables are composed of in sixteen (16) items in four (4) categories.

(1) Occurrence Date
- Set the time point when the accident occurred.

(2) Occurrence Area
- Country: Select the country where the accident occurred among neighboring countries.
- Facility: Record the facility where the accident occurred based on database for status of nuclear power plants in neighboring countries.
- Spot: Select information on the spot where the accident occurred. (The non-nuclear facility is considered in addition to single or multi-unit, and spent fuel pool.)

(3) Occurrence Scale
- Cause of Accident: Select the cause of accident among natural disaster, human error, terrorism or sabotage, and others.
- Radiation Emergency: Select the radiation emergency type in accordance with degree of severity for radiological accident in excess of Emergency Action Level (EAL).
- Status of facility: Select the status of power, reactor core, cooling system and containment building after the accident occurs.
- Source-terms Released: Select the qualitative amount of radioactive materials released into the environment due to the accident.

(4) Domestic Influence
- Airflow: Select the type of airflow affecting inflow (to our country) of radioactive plume resulted from the accident.
- Expected Exposure Dose: Select the expected level of exposure dose on the domestic area after accident occurs. (Even if this is typically proportional to the magnitude of accident, it is necessary to additionally consider an effect of airflow.)
- Radioactive Contamination
  - Immigrants: In case of requiring the exercise for taking actions in situations where contaminated people enters our country, select “Contaminated”.
  - Imported Products: In case of requiring the exercise for taking actions in situations where the imported products are contaminated with radioactivity, select “Contaminated”. (Food and industrial products are separately considered.)
  - Domestic Food Products: In case of requiring the exercise for taking actions in situations where agricultural, livestock, and fishery products produced in our country, select “Contaminated”.

2.2 Template for Exercise Scenario Variables

Table I shows the structure of the template for exercise scenario variables and exemplifies the result developed for the specific situation where an accident occurs, which is caused by a natural disaster in a neighboring country, Japan.

Table I: Example of Template for Exercise Scenario Variables

Category	Division and/or Section		Settings of Variables	Remarks
Occurrence Date	August/14/2018, 2:00 pm			
Occurrence Area	Country		☐ China ☑ Japan ☐ Taiwan	
	Facility		Refer to Database	
	Spot		☐ Single Unit ☑ Multi-Unit ☐ Spent Fuel Pool ☐ Non-Nuclear Facility	Units 3 and 4
Occurrence Scale	Cause of Accident		☑ Natural Disaster ☐ Human Error ☐ Terror/Sabotage ☐ Others	Earthquake and consequential tsunami
	Radiation Emergency		☐ Facility Emergency ☐ Site Area Emergency ☑ General Emergency	
	Status of Facility	Power	☐ All Powers are Available ☐ AC Power Loss ☑ Station Blackout	
		Reactor Core	☐ Intact ☑ Partially Damaged ☐ Totally Damaged	
		Cooling System	☐ Functional ☑ Loss of Cooling	
		Containment Building	☑ Intact ☐ Failure	
	Source-terms Released		☐ No Release ☐ Small Amount ☑ Large Amount	1,000 TBq expected
Domestic Influence	Airflow		☐ No Inflow ☐ Bypass Inflow ☑ Direct Inflow	
	Expected Exposure Dose		☐ < 0.01 mSv ☐ 0.01 ~ 1 mSv ☑ 1 ~ 10 mSv ☐ 10 ~ 50 mSv ☐ > 50 mSv	
	Radioactive Contamination	Immigrants	☐ Not Contaminated ☑ Contaminated	from Fukuoka Port to Busan Port
		Imported Products	☑ Not Contaminated ☐ Contaminated – Food ☐ Contaminated – Industrial	
		Domestic Food Products	☑ Not Contaminated ☐ Contaminated	

2.3 Development of Situational Scenario

Based on settings for scenario variables in the template, it can be possible to describe a situational scenario. The following is an exemplification of a specific situational scenario applicable to the emergency response exercise, which is prepared from information presented in Table I.

"At 2:00 pm on August 14th in 2018, there was a severe accident caused by earthquake and consequential tsunami at Genkai Nuclear Power Plant Units 3 and 4 located about 50 km west of Fukuoka. As the off-site region was expected to be affected by radioactive materials, General Emergency was issued. All powers and cooling functions in the plant were lost, and the reactor core was partially damaged. Accordingly, large amount of radioactive materials were released into environment, and it was estimated that the total amount of release was about 1,000 TBq. It was predicted that air current will flow directly from Japan to Korea, and the maximum value of expected exposure dose was estimated to be 2 mSv in Gyeongsangnam-do Province. Many people were contaminated with radioactivity in ships arriving at Busan Port starting from Fukuoka Port."

3. Conclusions

In this study, the template for scenario variables was developed for the purpose of setting up basic situations in the exercise design phase. This template consists of sixteen (16) items in four (4) categories, and can be used for generating a exercise-specific situational scenario by appropriately combining settings on variables such as the date, time, area, scale of the accident occurred, and domestic influence from the accident.

The scenario variables and situational scenario are applied to preparing exercise messages, and thereafter, to establishing the comprehensive exercise scenario in accordance with various situations where the nuclear accident may occur in neighboring countries.

Finally, the results of this study can provide a basis of the exercise system to respond quickly and efficiently when a nuclear accident occurs in neighboring countries, and moreover, can contribute to advancement of the emergency preparedness on a national level.

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REFERENCES

[1] Nuclear Safety and Security Commission, Radiological disaster in neighboring country-standardized manual of emergency management, 2016.
[2] Hyejin Kim, Juyoul Kim and Juyub Kim, Development of Training System for Emergency Response to a Nuclear Accident in Neighboring Country, Korean Nuclear Society Autumn Meeting, October 26-27, 2017.
[3] Hyejin Kim, Juyub Kim and Sukhoon Kim, Evaluation on the Source-term Release to Environment of a Nuclear Accident in Neighboring Countries for Development of Emergency Response Training System, Korean Nuclear Society Autumn Meeting, October 25-26, 2018.