Development of Training System for Emergency Response to a Nuclear Accident in Neighboring Country

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1. Introduction

In the Northeast Asia region where the Korean Peninsula is located, more than 100 nuclear reactors are in operation or under construction in China, Japan and Taiwan. As nuclear power plants are concentrated and new construction is expected to continue, it is necessary to continuously strengthen the emergency response system for radiological disaster in neighboring country.

In order to respond quickly and efficiently in the case of radiological disaster in neighboring country, conducting an infrastructure research to improve the emergency response system at the national level is required. Also, it is necessary to develop training scenarios, evaluation methodology and model to strengthen the periodic emergency response training system.

In this study, we develop a training system for preparing a radiological disaster occurred in neighboring country as a part of the advancement of the emergency response system.

2. Development of Training Methodology

2.1 Selection of Collaborative Function

One of the basic directions of the National Security Management Basic Plan is to establish a strong control tower and a collaborative system that integrates and supports the responding organizations in emergency. Therefore, when a disaster occurs, collaboration between related agencies should be built through 13 essential collaborative functions; situation management, urgent social stability, maintenance of site environment, traffic provision, promotion of disaster prevention, maintenance of social order, medical care and prevention, volunteer management, urgent repair of facility, energy recovery, resource support, urgent support of communication, search and rescue [1].

In the event of a radiation accident in neighboring country, the disaster managing department is the Nuclear Safety and Security Commission (NSSC). The collaborating organizations are limited to the main ministries among related organizations, but limited to the level of the institution holding the practical manuals. The collaborative organizations defined in this study are the following 21 organizations;

Nuclear Safety and Security Commission, National Security Office (crisis management center), The Office for Government Policy Coordination, Ministry of Public Safety and Security, Ministry of Strategy and Finance, Ministry of Science, ICT and Future Planning, Ministry of Education, Ministry of Foreign Affairs, Ministry of Justice, Ministry of National Defense, Ministry of Culture, Sports and Tourism, Ministry of Agriculture, Food and Rural Affairs, Ministry of Trade, Industry and Energy, Ministry of Health and Welfare, Ministry of Environment, Ministry of Land, Infrastructure, and Transport, Ministry of Oceans and Fisheries, Korea Communications Commission, Ministry of Food and Drug Safety, Korea Customs Service, Korea Meteorological Administration.

In this study, we selected 9 collaborative functions that can be applied in case of nuclear accident in neighboring country among the above 13 collaborative functions. Table I shows collaborative functions among corresponding organizations according to four levels of crisis alert. The four levels of crisis alert are in the standardized manual [2] of risk management prepared by Nuclear Safety and Security Commission.

2.2 Development of Training Scenario

A base study that enhances emergency response at the national level is required by supplementing the response manual for radiological disaster in neighboring country. In this study, we developed the anticipated scenarios and response systems by collecting, searching, and analyzing data such as related regulations and manuals on the radiological disaster in neighboring country.

Training scenarios that integrate the radiological disaster situation of neighboring country and the measures of related organizations according to the time of the accident are under development. Table II is the base accident scenario of Hongyanhe nuclear power plant in China and this can be utilized as prototype in development of training scenarios.

As a fundamental scenario, it is supposed that LOCA and SBO due to an earthquake occurred at Hongyanhe NPP in China, which has the shortest distance of about 500 km from Korea. Since the accident, air current may be introduced directly to the Korean peninsula, and thus serious phase is issued.

Table I: Collaborative Functions according to Crisis Alert Level

Function \ Level	Blue	Yellow	Orange	Red
Situation management	-Synthesizing and managing crisis information and situation			- Start and operation of Neighboring Country's Incident Response Center and the Central Disaster Relief Center - Operating National Crisis Evaluation Conference
	- Analysis and response to nuclear accident in neighboring country - Providing information on the public to the media	- Enhancing environmental radiation monitoring	- Early start of Neighboring Country's Incident Response Center and the Central Disaster Relief Center, if necessary - Analyzing and evaluating domestic radiation effects	
Resource support		- Supporting activities of related ministries such as contamination inspection, decontamination and exposure management - Supporting materials and human resources for radiation emergency medical care		
Maintenance of social order	- Access control for damaged area, maintenance of social order, prevention of public order			
Urgent social stability		- Preparing countermeasures to radioactive contamination inspection and shipment restriction for domestic agricultural, livestock, marine and processed products		- Performing radioactive contamination inspection and shipment restriction for domestic agricultural, livestock, marine and processed products
		- Performing radioactive contamination inspection and import restriction, if necessary, for agricultural, livestock, marine and processed products from nation occurring accident		
Traffic provision		- Restriction of aircraft flight against radioactive contaminated areas.		
			- Restriction of ship navigation against radioactive contaminated areas	
Medical care	- Establishing and checking cooperation for radiation emergency medical treatment support	- Taking Measures for victim's psychological and life stabilization - Assistance to radioactive contamination inspection of public in damage expected area - Installation of on-site medical center, operation of medical institution - Acquisition and use of medicines and medical equipment		
Maintenance of site environment	- Investigating characteristics of radioactive contamination in disaster area	- Establishment and implementation of decontamination plans for radioactive contaminated areas - Establishment of contaminated area and restriction of access to local public - Enforcement of traffic control measures		
Search and rescue	- Emergency relief action such as transportation of person contaminated to designated hospital			- Performing public protection action
Promotion of disaster prevention		- Support for disaster broadcasting and response to rumor via SNS		
			- Sending disaster message for the public - Support for disaster online broadcasting	

3. Development of Training Evaluation Model

Not only development of training scenarios but establishing an evaluation methodology that can enhance the effectiveness of training to respond for radiological disaster in neighboring country is necessary. In this study, the evaluation factors of 2016 Disaster Response Safety Korea Training Plan [3] were applied to the emergency response training system for radiological accidents in neighboring country. These factors evaluate the implementation of the four stages of emergency response training (training planning, design, implementation, evaluation and devising improvement plan) and include 13 evaluation areas (Fig. 1).

A training evaluation model was developed, reflecting characteristics of nuclear accident in neighboring country based on the Fig. 1. Table III suggests an evaluation model that can improve the training system by subdividing evaluation criteria for 23 evaluation factors. Each color in Table III indicates the corresponding evaluation area shown in Fig. 1.

Table II: Base Accident Scenario of Hongyanhe NPP

Time (hh:mm)	Situation Setting	On-site Situation	NSSC's Action
00:00	Scale 9.0 earthquake occurred near Hongyanhe NPP in China	Reactor trip	
		Occurrence of LOCA and SBO	
00:05		Establishing emergency plan and response center	- Recognizing and judging situation
00:10			- Issue of blue alert - Propagating the situation to the relevant organizations
00:30	Performing actions of blue step		- Checking cooperation system with related organizations - Establishing ways to manage the situation - Providing information to respond to media
01:00	Occurring severe accident	Determining core cooling failure, declaring emergency situation	- Issue of yellow alert - Propagating the situation to the relevant agencies
01:10			- Establishing a situation management team

01:20	Performing actions of yellow step	Ordering public evacuation	- Enhancing environmental radiation monitoring and open to the press - Supporting the response activities of related organizations such as contamination inspection, decontamination, exposure management - Conducting contamination inspection for the entry.
02:00	Release of Radioactive material	Core disruption	
		Hydrogen explosion	
02:05		Expanding radius of evacuation area	- Issue of orange alert - Propagating the situation to the relevant agencies
02:10			- Establishing Radioactive Central Control Center
02:20	Performing actions of orange step		- Analysis and evaluation of domestic radiation effects -Review of public protection action - Enhancing environmental radiation monitoring and open to the press - Supporting the response activities of related organizations such as contamination inspection, decontamination, exposure management
03:00	Inflow of radioactive material		- Confirmation of increased environmental radiation.
			-Discussing with National Security Office and Ministry of Public Safety and Security on issuing red alarm
03:05			- Issue of red alert - Propagating the situation to the relevant organizations
03:10			- Establishing and operating neighboring incident response center
03:20	Performing actions of red step		- Review and request of public protection action - Strengthening national environmental radiation monitoring system - Supporting radiation protection and radiation emergency medical technology. - Carrying out radioactive exploration for damage (expected) area and contamination inspection for local public cooperating with local governments, Ministry of National Defense, etc.
04:00	End of training		

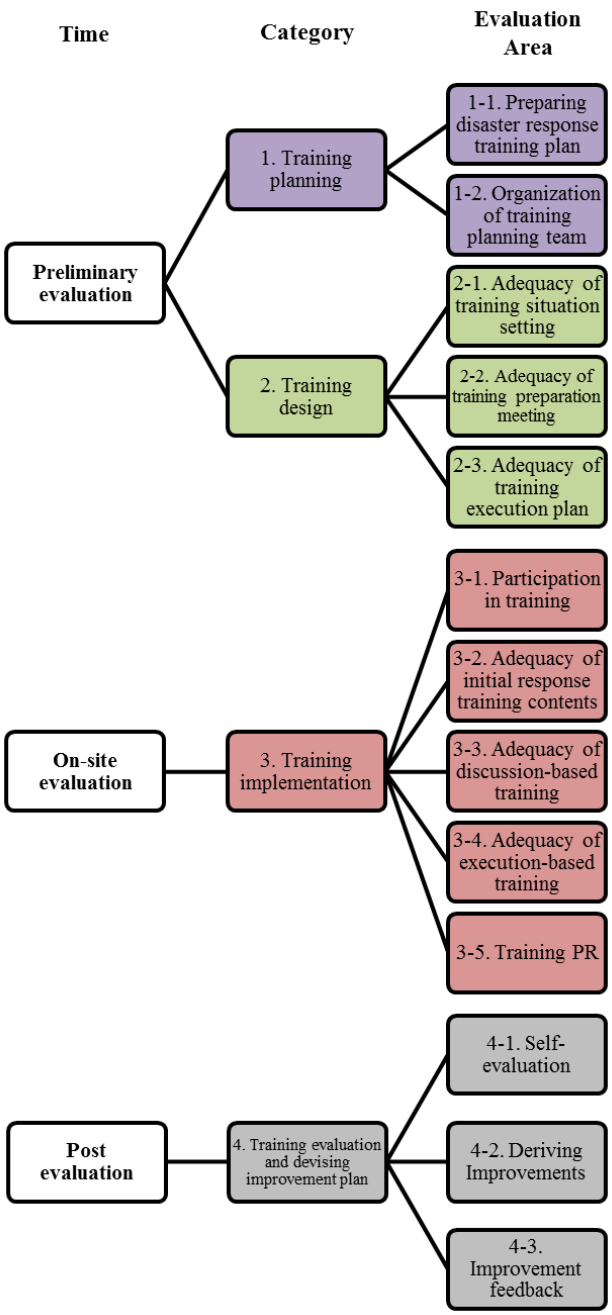

Fig. 1. Structure of Training Evaluation Model.

Table III: Training Evaluation Model

Evaluation Factor	Criteria
(1) Adequacy of crisis management manual	Confirmation of regulation on the disaster response rules in the crisis management manual
	Confirmation of individual mission card of crisis management manual
	Confirmation of the current status of the emergency network
(2) Adequacy of training plan by collaborative function	Confirmation of the establishment of plans for the collaborative function of nuclear accident in neighboring country
	Confirmation of managing department of collaborative function and core work
	Confirmation of approval by NSSC Chairperson for the collaborative function planning
	Confirmation of notification of collaborative function planning to institutions
(3) Adequacy of organization and operation of training planning team	Confirmation of the approval by the manager or higher position for organizing the training planning team
	Confirm that training planning team includes working-level of nuclear accident incidents in neighboring country
	Confirmation of work division such as command team, execution team, planning team under training planning team leader
(4) Adequacy of situation setting (scenario) by disaster type	Confirmation of training scenario
	Confirmation of application of the disaster characteristics in the training scenario
	Confirmation of realities of the training scenario
(5) Expert participation rate by disaster type	Confirmation of participation of relevant organizations, civilian experts, and civilian organizations in the training planning and design phase
(6) The specificity of the execution plan scope	Confirmation of necessary functions according to characteristics of accident in neighboring country
	Confirmation of resources required for accident in neighboring country
	Confirmation of the scope of training participating agencies and departments
	Confirmation of detailed schedule such as training time and place, etc.
(7) Substantiality of execution plan contents	Confirmation of situation notice and situation determining meeting
	Confirmation of operation of the following agencies; the Central Disaster Relief Center, the Central Emergency Control Center (Neighboring Incident Response Center), the Local Disaster Relief Center (metropolitan, elementary), the Local Emergency Control Center and the Consolidated Command Center
	Confirmation of implementation of situational linkage and mutual aid system among the following agencies; the Central Disaster Relief Center, the Central Emergency Control Center (Neighboring Incident Response Center), the Local Disaster Relief Center (metropolitan, elementary), the Local Emergency Control Center and the Consolidated Command Center
	Confirmation of correspondence for the press
(8) The interest of the training presiding officer	Confirmation of position of training presiding officer
	Confirmation of on-site inspection, observation and command by training presiding officer
	Confirmation of commanding solution to the problem and measures by training presiding officer
	Confirmation of the answer of training presiding officer
(9) Participation rate of training institutions	Confirmation of the number of actual training organizations versus the number of those on training plans or scenarios
(10) Adequacy of the situation propagation system	Confirm whether or not the relevant organization is involved in the target organization
(11) Substantiality of situation judgment meeting	Confirmation of availability of materials to identify disaster damage level
	Confirmation of formation and dispatch of practical group, and the scope of call for workers
	Confirmation of discussion by collaborative function such as prompt propagation of situation, maintenance of social order and urgent evacuation which is the most important in the beginning of a disaster
	Confirmation of determination on the crisis stage
(12) Fulfillment of operation of emergency equipment	Confirmation of presiding of meeting according to the operation regulations of neighboring incident response center
(13) Awareness of roles and duties of training participants	Confirmation of understanding of the roles and tasks of participants through inquiry
(14) Adequacy of discussion contents	Confirmation of division of collaborative functions according to the characteristics of accident in neighboring country
	Confirmation of deduction of mutual problems by collaborative function
	Confirmation of focus on problem solving that is most likely to occur
	Confirmation of the possibility of disaster spread in the future
(15) Adequacy of discussion process	Confirmation of promotion of voluntary participation and provision of sufficient participation, not just announcement of simple mission
(16) Initiative of participation in discussions	Confirmation of active participation in discussions to resolve mutual problems
(17) Adequacy of on-site training installation (place) and situation presentation	Confirmation of operation of actual disaster facilities and direction of real-time situation
	Confirmation of past disaster situation
(18) Awareness of participation rates and roles and responsibilities of on-site training institutions	Confirming the participation rate of the number of participating organizations in the on-site training compared to the number of those in the discussion-based training
	Confirmation of designated roles and responsibilities of organization in on-site training
	Confirmation of execution of commanding system during on-site training
	Confirmation of application of golden time to the training situation
	Confirming adequacy of step-by-step warning announcement (issuer, issuance procedure)
(19) Achievement of on-site training goal	Confirming achievement of on-site training compared to training goal
(20) Public information	Confirming the number of public relation type and performance
(21) Establishment and implementation of self-evaluation plan	Confirmation of establishment of self- evaluation plan
	Confirmation of affiliated and related organizations in the self- evaluation plan
	Confirmation of self- evaluation
(22) Problems, recommendations and achievements	Confirmation of deduction of problems, recommendations and achievements
	Confirmation of deduction of problems and achievements in initial response
	Confirming ratio of deduced cases compared to the number of organizations participating in training
(23) Progress compared with improvement	Confirmation of establishment of improvement planning
	Confirming specificity and feasibility of the improvement planning
	Confirming ratio of performance of improvement compared to deduced cases

4. Conclusions

In this study, we developed fundamental materials such as training scenarios and evaluation factors to establish the emergency response training system for nuclear accident in neighboring country. Through this study, it is possible to improve relative regulation and establish the countermeasures for the radiological disaster in neighboring country by supplementing the existing manuals.

For the enhancement of emergency response system, we can expect the economic effect of saving health and property damage by performing prompt public protection measures. It is also expected to provide a basis for meeting the demand on information of public for radiological disaster in neighboring country. Furthermore, the result of this study will strengthen the capability of international emergency response through the linkage of disaster prevention training of Northeast Asian countries.

ACKNOWLEDGMENTS

This work was supported by the Nuclear Safety Research Program through the Korea Foundation Of Nuclear Safety (KoFONS), granted financial resource from the Nuclear Safety and Security Commission (NSSC), Republic of Korea. (No. 1702004)

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