Preliminary Analyses of Nuclear Emergency Response Procedures in Korea for Application to Level 3 Probabilistic Safety Assessment

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1. Introduction

For the past experiences in nuclear power plant (NPP) operation around 60 years, there have occurred several severe accidents, which have radiologically affected wide areas around NPPs. Following these major events, nuclear emergency preparedness and response (EPR) system has been improved worldwide. Such system includes the way to make prompt decisions on public protective actions before and after radionuclide release into environment. Actions include evacuation, sheltering, relocation, food restriction, and so on.

For making timely and rational decisions against emergency, both licensees and governments should have sufficient response capabilities through education and training of personnel based on established manuals in advance. Within a manual, response procedures should be included for personnel to implement protective actions successfully within certain time objectives. Also, response manuals of each organization should be harmonized and connected with others to implement protective actions without confusion.

In this study, 5 documents concerning EPR system were reviewed to derive and suggest standardized procedures with time objectives to implement evacuation during severe accidents of NPPs in Korea. From the derived procedures, we discussed how them to be utilized in Level 3 probabilistic safety assessment (PSA), and how to improve current domestic manuals.

2. Materials and Methods

IAEA and domestic documents concerning EPR system were reviewed to derive standard procedures and time objectives. There were represented a series of various factors which could affect success and fail of evacuation of population in emergency planning zone (EPZ) during general emergency (GE) situation of NPPs. Among them, essential factors for implementing evacuation were selected, neglecting other trivial factors. If possible, factors that are hard to distinguish chronologically were incorporated as one factor, which would be useful for Level 3 PSA application. When response time objectives were expressed as cumulative time in a document, they were segmented, considering time difference of each step.

References are listed as follows; IAEA GS-G-2.1 [1], EPR-NPP PPA [2], EPR-RR [3], emergency plan of Kori NPPs [4], and onsite action manual of Busan metropolitan city [5]. Ref. [1] provides fundamental principles concerning EPR, and suggests different time objectives by classifying facilities into Threat Category I-III, and emergency situations into facility, local, and national Levels. Ref. [2] provides basis for developing tools and criteria in taking protective actions, and summarizes required actions in case of GE of light-water reactors. Ref. [3] provides emergency response procedures and time objectives of licensees for emergency of a research reactor. Refs. [4] and [5] explain response procedures for the licensee and the central/local government in Korea, respectively, during GE.

3. Results and Discussion

As a result, (a)-(g) were determined as main actions leading to evacuation and their time objectives, which will be analyzed by Level 3 PSA. Other trivial actions were neglected in the scope of this study. Responding organizations that are responsible for actions are indicated by different colors as in Fig. 1. Here, activation of offsite emergency response organization (ERO) is required in both local and central governments.

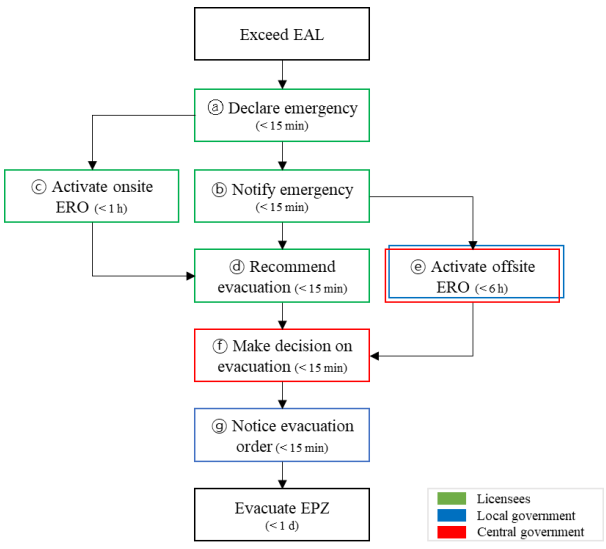

Fig. 1. Standard procedures and time objectives for evacuation during GE in Korea.

Time objectives were determined among different options suggested (Table 1), based on a rule as follows; shorter times were selected as the primary objectives for each procedure.

Table 1. Time objectives provided by Refs [1]-[4].

Actions	Ref. [1]	Ref. [2]	Ref. [3]	Ref. [4]
(a)	15 min	15 min	15 min	15 min
(b)	15 min	15 min*	15 min	15 min
(c)	1 h	-	2 h	1 h
(d)	30 min	-	15 min*	-
(e)	6 h	-	-	-
(f)	30 min	15 min*	-	-
(g)	1 h	15 min*	-	-

* Cumulative time was segmented considering time difference.

It is remarkable that there exists inconsistency among references, even in publications from the same organization, IAEA. Such time differences would be considered as a variety of success/fail options in the stage of event trees development for Level 3 PSA analysis. It should also be noted that recommendation of evacuation by licensees, which is an essential procedure to make decision on evacuation, but this action was missing in Ref. [2].

Time objectives of actions (d)-(g) were not provided in domestic manuals. Such missing points should be supplemented in future in order not to cause any confusion and time delay during decision-making. For example, activation of offsite ERO was found to be the most time-consuming action, so procedures of such action should be provided in detail during different accident scenarios. For example, simplified ERO activation conditions such as minimum number of agents and alternative attendance method (e.g., online conference system) could be described.

4. Conclusion

In this study, IAEA and domestic documents related to EPR system were investigated to develop standard response procedures during GE in Korea. Such procedures were developed for Level 3 PSA application, where there is a need to assess which response action is sensitive to success and fail of evacuation. Event trees [6, 7] and fault trees will be developed based on the derived procedures.

It was found that there have been suggested different time objectives for the same response action by different references. Although the shortest time was selected as objectives primarily in this study, others will be reflected as alternative success/fail conditions when developing followed event trees. In addition, it was found that specification of detailed procedures in domestic manuals is necessary for different accident scenarios, especially in case of offsite ERO activation. Lessons learned from practical experiences in actual accident management or maintenance of response capabilities will be important to complement the manuals in future.

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