A Study on the Development of Improved Event Severity Evaluation Framework

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1. Introduction

An integrated framework for evaluation of event significance developed early in 2010 (which is named as KNES framework[1]). This framework allowed determination of the integrated event significance and the appropriate level of event response. However, the improvement of KNES framework was needed because the framework had the following limitations :

- The KNES framework had some overlaps between the specific factors in matrices in many steps.
- The KNES framework had not detailed guideline for event severity determination in some steps (for example, human factor assessment steps)
- It was not easy to determine the event severity within a short time using the KNES framework. Etc.

The KNES framework developed in 2010 has been recently improved by Korea Institute of Nuclear Safety (KINS). This paper describes the basic concept of the improved framework for evaluation of event significance, focusing on the assessment hierarchy.

2. The Improved Event Severity Evaluation Framework

The hierarchy of the improved event severity evaluation framework is shown in Fig. 1 [2].

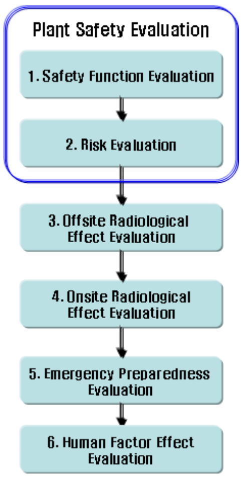

Fig 1. Assessment hierarchy for the improved framework developed in 2011

Each of six steps in the assessment hierarchy of Fig. 1 is discussed below with the associated blocks.

(1) Safety Function Evaluation - The effect of DID (Defense In Depth) degradation by the event is evaluated in this step. It is evaluated in terms of "safety function", and divided as IE (Initiating Event) and MS (Mitigation System). IE represents the severity of initiating events and composed of five grades as presented in Fig 3. MS represents the event mitigation capability and composed of four grades. The various types of event, e.g., internal or external initiating events that occurred during at-power or shutdown conditions, can be analyzed in this step. IE is composed of five grade, and MS is composed of four grade The event severity determination scheme in this step is presented in Fig 2.

Initiating Event / Mitigation System	IE-5 / IE-4	IE-3	IE-2	IE-1
MS-4	Green	White	White ~ Yellow	Red
MS-3	White	White ~ Yellow	Yellow ~ Red	Red
MS-2	White ~ Yellow	Yellow ~ Red	Yellow ~ Red	Red
MS-1	Red	Red	Red	Red

Fig 2. Event Severity Determination Scheme in "(1) Safety Function Evaluation" Step

(2) Risk Evaluation – The event severity can be evaluated quantitatively using the PSA model. In this step, the event severity is evaluated in terms of CCDP (Conditional Core Damage Probability) which is the level 1 PSA measure. Because the regulatory PSA model (MPAS) has been developed only for internal events at power Level-1 PSA model, only internal initiating events at power can be analyzed in this step. The event severity determination scheme in this step in terms of CCDP is presented in Fig 3.

RED	1E-4 < CCDP
YELLOW	1E-5 < CCDP < 1E-4
WHITE	1E-6 < CCDP < 1E-5
GREEN	CCDP < 1E-6

Fig 3. Event Severity Determination Scheme in "(2) Risk Evaluation" Step

(3) Offsite Radiological Effect Evaluation - If the event involved offsite radiological consequences, the event severity can be evaluated in this step. Fig 4 presents event severity determination scheme in this step. It can include not only the real offsite radiological effects of events, but also the potential effects (e.g., radiation monitoring instrumentation availability, etc).

Fig 4. Event Severity Determination Scheme in "(3) Offsite Radiological Effect Evaluation" Step

(4) Onsite Radiological Effect Evaluation - If the event involved onsite radiological consequences, the event severity can be evaluated in this step. Fig 5 presents event severity determination scheme in this step. It can include not only the real onsite radiological effects of events, but also the potential effects (e.g., radiation alarm availability, etc).

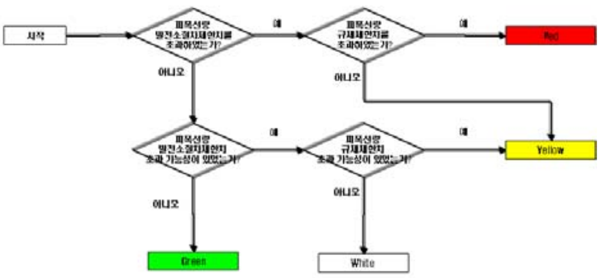

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Fig 5. Event Severity Determination Scheme in "(4) Onsite Radiological Effect Evaluation" Step

(5) Emergency Preparedness Evaluation – If the event involved emergency alarm based on the emergency action level in NPPs, the event severity can be evaluated in this step using the severity determination scheme presented in Fig. 6 based on 10CFR50.47.

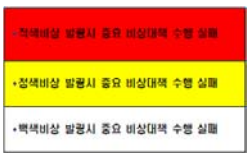

Fig 6. Event Severity Determination Scheme in "(5) Emergency Preparedness Evaluation" Step

(6) Human Factor Evaluation – If the event involved human error, the event severity can be evaluated in this step using the HuRAM+ (Human related event Root cause Analysis Method) procedure[3]. HuRAM+ is the event investigation method to identify the root cause of inappropriate human actions. Fig 7 presents event severity determination scheme in this step.

Fig 7. Event Severity Determination Scheme in "(6) Human Factor Evaluation" Step

4. Conclusion

The improved framework for evaluation of event significance discussed in this paper has the following characteristics [2] :

- The improved framework removed some overlaps between the specific factors existed in the previous KNES framework.
- The improved framework has the specific guideline for event severity determination.
- The improved framework makes it easy to determine the event severity within a short time. Etc.

In order to facilitate application of the improved framework, the application study for the various NPP event will be needed.

ACKNOWLEDGMENT

This work has been carried out under the Nuclear R&D program supported by the Ministry of Education, Science and Technology, Republic of Korea.

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