The Establishment of Weighting Factors and Threshold for Screening Safety-Significant SSCs to Implement the Maintenance Rule

Using Delphi Process

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1. Introduction

This paper describes a method and results establishing the weighting factors for plant functions and threshold for screening the safety-significant structures, systems, and components(SSCs) to implement the Maintenance Rule (MR) using Delphi Process. In implementing the MR, it is required to screen the SSCs that are significant contributors to safety as identified through a blended risk-informed process that uses Probabilistic Safety Assessment(PSA) insights, operating experience and new technical information using expert panel evaluations. Decision making through the expert panel is an important part of implementing the MR because we cannot get all of the necessary information from PSA results. In this study, we used Delphi process for elicitation of the expert opinions. Hence, We established the weighting factors for the plant functions and estimated the threshold to screen out the low safety-significant SSCs.

2. Method and Results

2.1 Classification of Plant Functions

Plant functions are classified into the accident response functions and normal operation functions to establish the weighting factors. We used the same questionnaires developed in NUMARC 93-01[1]. Each function for accident responses were developed in the view point of Defense in Depth(DID), redundancy, diversity, independence and single failure, and the normal operation functions were developed in the view point of functions such as the reactor cooling, steam generation, power conversion, pressure boundary control, supporting system, electrical system and I&C system[2]. The developed questionnaires are as follows:
For accident response function;

1. Required to shutdown the reactor and maintain it in a safe shutdown condition
2. Required to maintain the reactor coolant pressure boundary
3. Required to remove heat and radioactivity from containment and maintain containment integrity
4. Required to remove heat from the reactor

For normal operation function;

1. Required to provide primary side heat removal
2. Required for power conversion
3. Required to provide primary, secondary or containment pressure control
4. Required to provide cooling water, component or room cooling
5. Required to provide electric power
6. Required to provide other motive or control power

2.2 Delphi Process

For Delphi process[3][4][5], the panel consisted of 5 experts in the fields of PSA, DID, operation and accident analysis, and the guidelines for assigning the weighting factors are provided to the experts. The questions were repeated 3 times. At the 1st round, only the guidelines with simple descriptions are provided, but at the 3rd round, the more detailed descriptions were added for the questions that the experts have some misunderstanding.

2.3 The Results

Figure 1 shows the weighting factors established and NUMARC weighting factors.
Table 1 shows the threshold according to the changes of the weighting for accident response functions. The threshold screening the safety-significant SSCs is inferred from the summation of all of the maximum weighting factors. In this step, we recommended the value of multiple 3 for accident response functions' weighting factors considering the background of adopting the MR in Korea. Afterward, threshold will be adjusted considering the relation with Risk Monitor color band, and the criteria of safety significant SSCs in Option 2 and RI-ISI implementation.

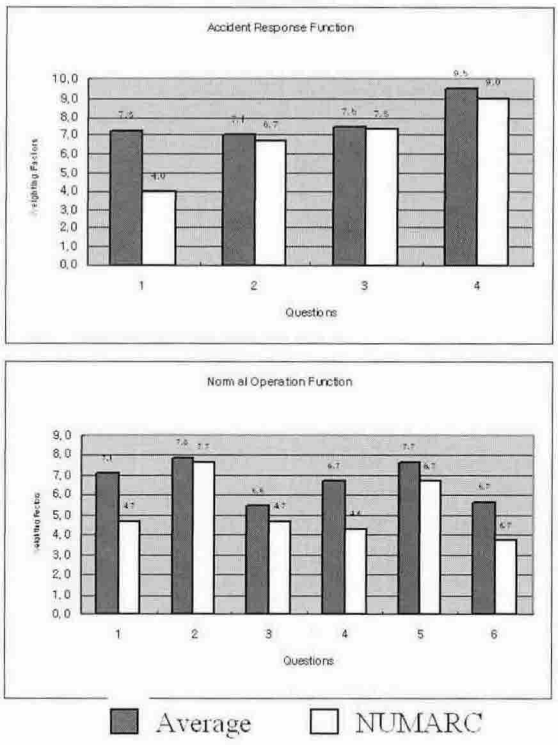

Figure 1. The 3rd round result

Table 1. Threshold Value

Weighting for accident response functions	Threshold Value	Remarks
X3	404	Recommended
X2.5	357	
X2	310	
NUMARC(X3)	334	

3. Conclusions

The weighting factors for accident response functions except for question 1 were similar to those of NUMARC93-01. However, the weighting factors for normal operation functions were higher than those of NUMARC 93-01[1]. We think those difference comes from the philosophy for plant operation. Using the value of multiple 3 for accident response functions' weighting factors will be appropriate when we consider the background of adopting the MR in Korea.

References

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