

Determination of Safety Performance Grade of NPP Using Integrated Safety Performance Assessment (ISPA) Program

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1. Introduction

Since the beginning of 2000, the safety regulation of nuclear power plant (NPP) has been challenged to be conducted more reasonable, effective and efficient way using risk and performance information. In the United States, USNRC established Reactor Oversight Process (ROP) in 2000 for improving the effectiveness of safety regulation of operating NPPs. The main idea of ROP is to classify the NPPs into 5 categories based on the results of safety performance assessment and to conduct graded regulatory programs according to categorization, which might be interpreted as "Graded Regulation". However, the classification of safety performance categories is highly comprehensive and sensitive process so that safety performance assessment program should be prepared in integrated, objective and quantitative manner. Furthermore, the results of assessment should characterize and categorize the actual level of safety performance of specific NPP, integrating all the substantial elements for assessing the safety performance.

In consideration of particular regulatory environment in Korea, the integrated safety performance assessment (ISPA) program is being under development for the use in the determination of safety performance grade (SPG) of a NPP. The ISPA program consists of 6 individual assessment programs (4 quantitative and 2 qualitative) which cover the overall safety performance of NPP. Some of the assessment programs which are already implemented are used directly or modified for incorporating risk aspects. The others which are not existing regulatory programs are newly developed. Eventually, all the assessment results from individual assessment programs are produced and integrated to determine the safety performance grade of a specific NPP.

2. Development of ISPA Program

The ISPA program consists of six significant individual sub-programs which assess the overall safety performance of NPP. The sub-programs are divided into 4 quantitative assessment sub-programs and 2 qualitative assessment sub-programs. The quantitative assessment sub-programs are risk assessment of inspection findings, risk assessment of operational accident/event, risk-informed performance indicators, and risk management. All quantitative assessments are directly related to the increase in CDF

(Δ CDF) and the results are represented by 4 color coding scheme (Green, White, Yellow, Red). In doing so, following counting rule may be applied; one upper level color can be produced by adding 3 lower level colors. The criteria for the colors are shown in Table 1.

The qualitative assessment sub-programs are maintenance effectiveness monitoring program and assessment of safety culture. The assessment results are expressed as either "Acceptable" or "Unacceptable". The assessment results from 6 sub-programs are integrated to produce overall safety performance grade (SPG) of a specific NPP. The structure of ISPA program is shown in Fig.1.

3. Determination of Safety Performance Grade Using ISPA Results

It is appropriate to categorize the SPGs into 4 groups, which are "Excellent", "Average", "Caution", and "Poor", based on the assessment results and considering the graded regulation application. The amount of total Δ CDF and expected portion of NPPs for each group are estimated approximately, as shown in Table 1.

In order to determine the SPG of a NPP, the assessment results of 6 sub-programs are integrated under following criteria. Basically, the preliminary SPG is determined by integrating 4 quantitative assessment results and, by considering 2 qualitative assessment results, the final SPG of a NPP is determined, as shown in Table 1. For instance, if the quantitative assessment results are all "Green" and qualitative assessment results are all "Acceptable", then the SPG of NPP is "Excellent". However, even though

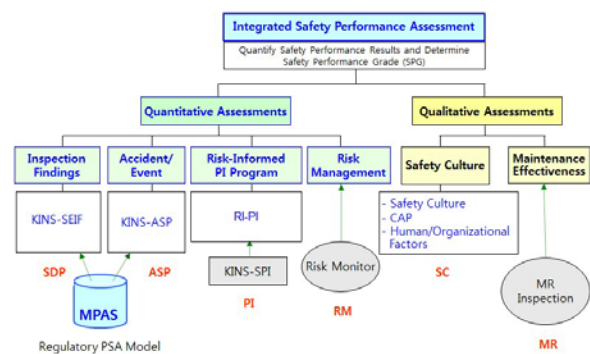


Fig.1 The structure of ISPA program

Table 1. Categorization of Safety Performance Grades Using ISPA Results

Criteria	Poor		Caution		Average		Excellent
	More than 2 "RED"	1 "RED"	1 "RED"	1 or 2 "YELLOW"	1 or 2 "WHITE"	All "GREEN"	All "GREEN"
CDF Increase	> 10 times		> 100%		> 10%		< 10%
Qualitative Results (2 Items)		1 or 2 "Unacceptable"	All "Acceptable"			1 or 2 "Unacceptable"	All "Acceptable"
Expected Portion of NPPs	< 5%		5-10%		~50%		~40%
Regulatory Response	Focused and Enhanced Inspection on the area and items of more than "WHITE", proportional to the significance		Focused and Enhanced Inspection on the area and items of more than "WHITE", proportional to the significance		Existing Inspection (Basic+Additional)		Basic Inspection
Counting Rule	- GREEN ($\Delta CDF < 10^{-5}$) Results Have No Impact on Classification - 3 WHITE ($\Delta CDF = 10^{-5} - 10^{-6}$) = 1 YELLOW ($\Delta CDF = 10^{-6} - 10^{-7}$), 3 YELLOW = 1 RED ($\Delta CDF > 10^{-7}$)						
NOTE	- Expected Portion of NPP may be different in actual assessment results - Classification is based on quantitative results, adjusted by qualitative results						

the quantitative assessment results are all "Green", the SPG of NPP may be "Average" if one of 2 qualitative assessment results is "Unacceptable". In the same manner, if the quantitative assessment results produce one "Red" and one of 2 qualitative assessment results is "Unacceptable", then the SPG of NPP is "Poor". However, even though there is one "Red", the SPG of NPP may be "Caution" if 2 qualitative assessment results are all "Acceptable". Nevertheless, the SPG of NPP should be "Poor" if there are more than 2 "Red" results, regardless of qualitative assessment results.

4. Principles for Grading Regulatory Inspection Program

As shown in Table 1, the regulatory response for each SPG group is grading regulatory inspection program corresponding to the severity level. To do so, it is necessary that the existing periodic inspection items are classified into 2 categories, which are "basic" and "additional". Several types of criteria may be applied to this categorization, which are related to risk significance, contribution to unplanned scram, number of inspection findings and events for each inspection item. If the relationship with any one type of criteria is strong, the inspection item may be classified as "basic" inspection items. Otherwise, the inspection item may be classified as "additional" inspection items

The basic approach for this graded regulation is as follows; For the NPPs categorized in "Excellence" group, the regulatory inspection program may be relaxed to conduct basic inspection only. For "Average" group, the existing regulatory inspection program is maintained to conduct both "basic" and "additional" inspection. For "Caution" and "Poor" groups, the existing regulatory inspection program is also maintained to conduct both "basic" and "additional" inspection. However, inspection may be focused on those inspection area and items which are related to more than "White" results, and the inspection activities and resources may be increased proportionally to the significance. Furthermore, the special and/or augmented team inspection may be conducted for the NPPs in "Poor" group, as necessary.

5. Conclusions

The integrated safety performance assessment (ISPA) program is being under development for the use in the determination of safety performance grade (SPG) of a NPP. The ISPA program consists of 6 individual assessment programs (4 quantitative and 2 qualitative) which cover the overall safety performance of NPP. The assessment results from 6 sub-programs are integrated to produce overall safety performance grade (SPG) of a specific NPP. The regulatory inspection program may be classified into 2 categories and conducted differently corresponding to the SPG of NPP.

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