

Development of Methodology for the Evaluation of Relationship between Safety Culture and Safety Performance

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1. Introduction

Safety culture has been recognized as a key to achieve high level of nuclear safety, as several recent events were found to have important implications for safety culture. Many studies revealed the fact that the defect of safety culture of the organization could be a cause of the degradation of safety performance in nuclear power plant. However, the relationship between safety culture and safety performance are not clearly identified so far.

This paper suggests a new methodology for evaluation of the relationship between safety culture and safety performance. The methodology is comprised of two parts. Firstly, the factors and the corresponding indicators for representing the safety culture were developed and they were scored using 5 point scale. The second part is for evaluating the weight of each of safety culture factors using the result of incident analysis. The methodology developed here enables to find significant safety culture factors and to achieve desired level of the nuclear safety.

2. Evaluation of the Level of Safety Culture

For assessing the level of safety culture, the safety culture factors and corresponding indicators were developed, which have dependency to safety performance of the organization. The effort was placed on to cover up all relevant areas in the organization.

2.1 Safety Culture Factor

Through literature survey, expert interview and discussion, 22 safety culture factors in 5 categories have been developed. During the developing stage, following two aspects were focused; 1) all possible factors which can affect safety performance must be included and 2) they must be able to be used in incident analysis.

2.2 Safety Culture Indicator

Safety culture indicators corresponding to relevant safety culture factors have been identified based upon the indicators developed by Korea Institute of Nuclear Safety (KINS) [1] or International Atomic Energy Agency (IAEA) [2]. When there is no relevant indicator, new indicators have been developed. Safety culture indicators and factors developed in this study are preliminary ones and will be improved by further investigations.

Table 1. Safety Culture Factors and Indicators

Category	Safety culture factor	<i>i</i>	Safety culture indicator
1. Political support	1.1 Goal prioritization	1	Ratio of safety goal execution and planning
	1.2 Role & responsibilities	2	Number of occurrence of responsibility problem
	1.3 Effectiveness of decision making	3	Number of complete achievement of PNSC meeting follow-up measure
	1.4 Safety encouragement	4	Number of head's a round of inspection
	1.5 Human resource allocation	5	Man-power support
	1.6 Resource allocation	6	Material support
2. Work management	2.1 Formalization	7	Procedure amendment backlogs
	2.2 Work environment	8	Level of arrangement and cleanliness of work environment
	2.3 Coordination of work	9	Number of shifts
	2.4 Quality assurance	10	Number of quality assurance training and quality improvement activity
	2.5 Design modification	11	Design modification backlog
3. Technical ability	3.1 Personnel selection	12	Working year in specializing area
	3.2 Co-operation control	13	Number of safety training to contractor
	3.3 Technical knowledge	14	Number of problem found by internal test not by external test
	3.4 Training	15	Average employee training time
	3.5 External technical support	16	Number of external safety review requested spontaneously
4. Organizational learning	4.1 Operating experience spreading	17	Number of experiences spreading other plants
	4.2 Performance evaluation	18	Number of operating experience analysis and treatment
	4.3 Corrective work	19	Number of complete corrective action
	4.4 Problem identification	20	Number of self safety test and quality inspection
5. Communication	5.1 Internal communication	21	The frequency of Mi-kep System usage
	5.2 External communication	22	Number of accident or event release

2.3 Rating of Safety Culture Factor, R_i

Degree of deterioration of safety culture factors can be measured by rating (R_i). The safety culture factor and the corresponding indicator can be scored using the 5-point scale as follows.

1	2	3	4	5
Very Good	Good	Normal	Bad	Very Bad

Based upon the "Preliminary Result of Safety Culture Evaluation in Nuclear Power Plant" by Korea Hydro & Nuclear Power Company (KHNP)[3], the ratings for safety culture factors were determined to a existing nuclear power plant. If there were no data, normal score of 3 was assumed.

3. Quantitative Influence Evaluation

The weight for each of safety culture factors needs to be evaluated to analyze relationship between safety culture and safety performance, because each of safety culture factors has different degree of contribution to safety performance. In this paper, the new framework for evaluating the weight has been proposed by using the result of incident analysis to improve the objectivity of the result.

3.1 Weight of Safety Culture Factor, W_i

Reactor trip events have been investigated for evaluation of the weight for safety culture factor. Trip event reports for whole domestic nuclear power plants for last 10 years (Jan. 1994 ~ Jan. 2004) were collected and it was 94 events total during this period. These events were analyzed to identify the cause of the reactor trip event in the aspect of safety culture. The degree of contribution of each of safety culture factors on reactor trip event was estimated by using 5-point scale. By normalizing contributions of each of plant's safety culture factors, the weight of safety culture factor W_i can be computed. The weight of safety culture factor W_i represents the degree of contribution of i -th safety culture factor on the reactor trip frequency which is one kind of a measure of the safety performance.

3.2 The Weighted Rating of Safety Culture Factor

The important safety culture factor relevant to safety performance can be identified by determining the weighted rating of safety culture factor as follows,

The Weighted Rating of Safety Culture Factor i
 $= W_i \times R_i$

Table 2 shows priorities of safety culture factors can be changed by considering the results of weight. For example, "2.1 formalization" was positioned in the second to the fifth rank when only the rating was considered, but it was positioned in the first rank after the weight as well as the rating was considered.

Table 2. Prioritization result of safety culture factors

Pri- ority	Weight (W_i)	Rating (R_i)	Weighted Rating ($W_i \times R_i$)
1	2.1 formalization	3.4 training	2.1 formalization
2	2.4 quality assurance	Same rating (2.1 formalization, etc)	2.4 quality assurance
3	2.2 work environment		3.4 training
4	3.4 training		2.2 work environment
5	2.3 coordination of work		2.3 coordination of work

Safety culture factors that need to be improved first can be found effectively by evaluating the weighted rating of safety culture factors. It is because not only the degree of deterioration but also the degree of contribution of safety culture factors on safety performance can be addressed using the values of weighted rating ($W_i R_i$). Degree of deterioration of safety culture factors can be measured by rating (R_i) and degree of contribution of safety culture factors on safety performance can be measured by weight (W_i).

4. Conclusion

In the paper, the new methodology for evaluating the influence of safety culture on safety performance is suggested to identify factors that need to be improved first. The concept of weighted rating is adopted and the weighted results are compared to find key factors. The reactor trip analysis results are used to evaluate the weight and the rating approach is referred to the results of KHNP [3]. Further study and experts' opinion can supplement the objectivity problem related with the factor and the indicator set.

REFERENCES

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