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Suggestion of a nuclear safety culture monitoring process

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1. Introduction

The safety of nuclear power plants cannot be overemphasized. The safety culture awareness is always emphasized and valued because the safety of a nuclear power plant is very much influenced not only by the safety of a design, but also by employees' safety culture awareness. Therefore, safety culture assessment is implemented periodically at nuclear power plants to measure employees' awareness of safety culture. The safety of nuclear power plants is continuously enhanced by improving the vulnerabilities identified by the assessment. However, there is a problem that safety culture assessment is implemented over a short period of time, and only the safety climate of the nuclear power plants at that time can be reflected. In addition, the reliability of assessment result could be impacted by generous survey responses and pre-prepared interview answers. Despite ensuring that there is no comparison of results between power plants and thoroughly anonymity in assessing safety culture, employees believe that the assessment results have a negative effect on the performance evaluation of the plant or on the individual. These fears interfere with employees' candid answers and often distort the assessment results. Thus, a process is needed to improve these problems and to continuously monitor safety culture.

However, if new duties for monitoring safety culture are added or additional personnel are needed, it will negatively affect the voluntary safety awareness of employees. Safety culture should be naturally achievable in the process of employees faithfully carrying out their duties. In nuclear power plants, employees from many departments are working together on a variety of tasks, and these tasks are being organically linked through a number of processes.

Systems monitoring the degradation of safety culture should be built and operated within these business processes. In general, there are two ways to monitor the degradation of safety culture. The first is to monitor performance and trend based on quantified data through operation of safety culture indicators. The second is to observe the behavior of employees through the operation of safety culture conference and to judge the signs of degradation on the basis of main insights.

These two methods can be powerful in achieving a healthy safety culture if used simultaneously as complementary relationships. Therefore, this paper proposes a monitoring process that utilizes both of these.

2. The status of nuclear safety culture monitoring on worldwide

The IAEA began developing a framework for establishing safety indicators at nuclear power plants in 1995 and was completed in 2000 [1]. These indicators were developed to provide objective information about the safety performance of nuclear power plants related to public safety. They evaluate trends and conditions in the main areas of safety performance to indicate early signs of decline. These consist of three attributes associated with a nuclear power plant: normal operation, emergency operation, and safety attitude of the workers. Among these attributes, the "safety attitude of workers" attribute is related to safety culture. Because safety culture or attitude-related indicators cannot be directly measured, they have extended to easy quantification or measurable indicators. This allows us to quickly identify problems in related areas. Safety culture might be identified and inferred on the basis of the conditions shown by various indicators, even though there is no single indicator to measure it because safety culture is a comprehensive concept. WANO operates 10 performance indicators used in all nuclear power plants around the world [2]. These indicators are used to observe the safety performance of the nuclear power plant as a whole and to encourage good performance through comparative analysis. These indicators are entirely concentrated on plant performance and do not include safety culture indicators. In domestic nuclear power plants, the implementation indicators for monitoring safety culture were developed and introduced for the first time in 2014 and are currently applied to all nuclear power plants [3]. The purpose of this indicator is to encourage employees to make safety culture a daily life throughout the work of the nuclear power plant, and was selected by considering the employees' implementation according to the KHNP safety culture principles. Monitoring safety culture based on indicators has limitations in identifying a comprehensive safety culture because it is likely to distort the overall phenomenon by focusing on a fragmentary specific phenomenon.

U.S. nuclear power plants operate safety culture conferences in accordance with NEI 09-07 [4] issued in November 2010 to monitor safety culture vulnerabilities in the nuclear power plant as a whole. The safety culture conferences include the Nuclear Safety Culture Monitoring Panel (NSCMP) and the Site Leadership Team (SLT). The NSCMP is designed to monitor the process inputs of a nuclear power plant that represent

the health of safety culture, identify potential concerns and strengths that require additional attention, and report to SLT. SLT is responsible for taking action by capturing signals that show safety cultural issues by reviewing various information (including the NSCMP report) indicating the soundness of the work environment. The information reviewed by the safety culture conference is the safety culture related data (process input) entered into the corrective action program (CAP) used by all departments of the nuclear power plant. Process Input includes NRC inspection results, safety culture assessment result, industrial evaluation, operation experience, QA (Quality Assurance), Self-Assessment (SA), Benchmarking, Behavioral Observation, ECP (Employee Concern Program), workforce issue, CAP evaluation, and plant performance trend.

The NEI 09-07 guidance was revised in 2014 to reflect the practical problems of the nuclear power plant and to provide five options for the autonomy of process selection and input components. Although Revision 0 of the guideline was interested in data review and trend, Revision 1 recommends that the flexibility of the conference operation be broadly presented and utilized in accordance with the nuclear power plant situation. The newly proposed option, the Fleet Nuclear Safety Executive Team (FNSCET), has been added for use by organizations operating NPPs collectively. Safety culture cannot be measured quantitatively as an intangible concept, but it can monitor the healthy safety culture of an organization through behavioral observation of its members and improve their behavior. Therefore, these safety culture conferences are not only operated by U.S. nuclear power plants such as Entergy, Exelon, Duke Energy, TVA, but also by Canadian nuclear power plants such as Bruce Power and Darlington. The domestic nuclear power plant has also been operating safety culture conferences in accordance with the situation of nuclear power plant since 2015, the NSCMP is held every quarter, and the SLT is held in half a year.

3. Nuclear Safety Culture Monitoring Process

It is recommended that the safety culture monitoring at nuclear power plants be carried out without any additional duties within the scope of existing duties of employees, although it is recommended to utilize both safety culture indicators and safety culture conference. Otherwise, it would have a negative impact on the safety awareness of employees and information monitored is likely to be distorted in the end. The safety culture monitoring process is divided into a significance determination process and the indicator monitoring process, as shown in Figure 1, and the significance determination process is operated on the basis of SLT(or NSCMP) organized at a nuclear power plant. The FNSCET organized at the head office manages the two processes integrally. The decisions of both SLT and FNSCET will affect employees' basic assumption, shared value and artifact in the organization through feedback on an organization's system, manager's leadership and employee behavior. Changes in employees' perception and system will be reflected in the daily work of employees.

3.1. Indicator Monitoring Process

The indicator monitoring process helps employees to gain safety culture insights based on data or information that is automatically generated when working at nuclear power plants. This process consists of three elements: "Safety Culture Indicator", "Safety Culture Assessment" and "Event-based Safety Culture Analysis."
When the data (information) corresponding to these elements shows abnormal condition or above the threshold value, the FNSCET should conduct a detailed review and comprehensively assess the organization's safety culture. These judgment must be linked to what was considered (or decided) in SLT. Safety cultural indicator, as indicator for employees' implementation at nuclear power plants, show the performance of the employees' practices according to the safety culture principles. For example, the first principle of safety culture, the actions of the workers involved in "all individuals take personal responsibility for safety," are defined as compliance with the regulations and procedures. They are made by calculating the number of cases of procedural violations and the number of regulatory counts.

"Safety Culture Assessment" represents the results of safety culture assessment conducted by the Headquarter every two years. The survey results showing year-to-year trends in the corresponding nuclear power plant provide meaningful information. Although interview results cannot be quantified, the level of their basic assumptions might be marked if a situational interview method for measuring the basic assumptions of employees is developed. "Event-based Safety Culture Analysis" represents the results of safety culture cause analysis for major plant failures or events. The analysis results might be evaluated for their frequency and trend by matrixing them according to the safety culture principle.

3.2. Significance Determination Process

This process helps to monitor a healthy safety culture by observing the behavior of employees at their daily work. This process consists of three elements: "Daily work monitoring", "Precursor and Behavior Observation", and "Safety Culture Indicator"

"Daily work monitoring" represents to monitoring safety culture while performing tasks such as Corrective

Action Program trend analysis, Self-Assessment, Operating Experience, Employee Concern Program, etc. Actions required according to the monitoring results are reviewed and determined in Site Leadership Team. "Precursor and Behavior Observation" represents that plant managers identify their violations of regulations or recurring problems while observing employees' testing or work. "Safety cultural indicator" is an element of the indicator monitoring process. However, it is included in this process because it is the main information that should also be provided in SLT. In addition, the information on issues that occur irregularly or require confidentiality (e.g., personnel issues, regulatory issues, etc.) is addressed in the Significance Determination Process. SLT should be operated to induce all employees to pay attention to issues important to safety culture during their work performance and to influence their daily work and behavior.

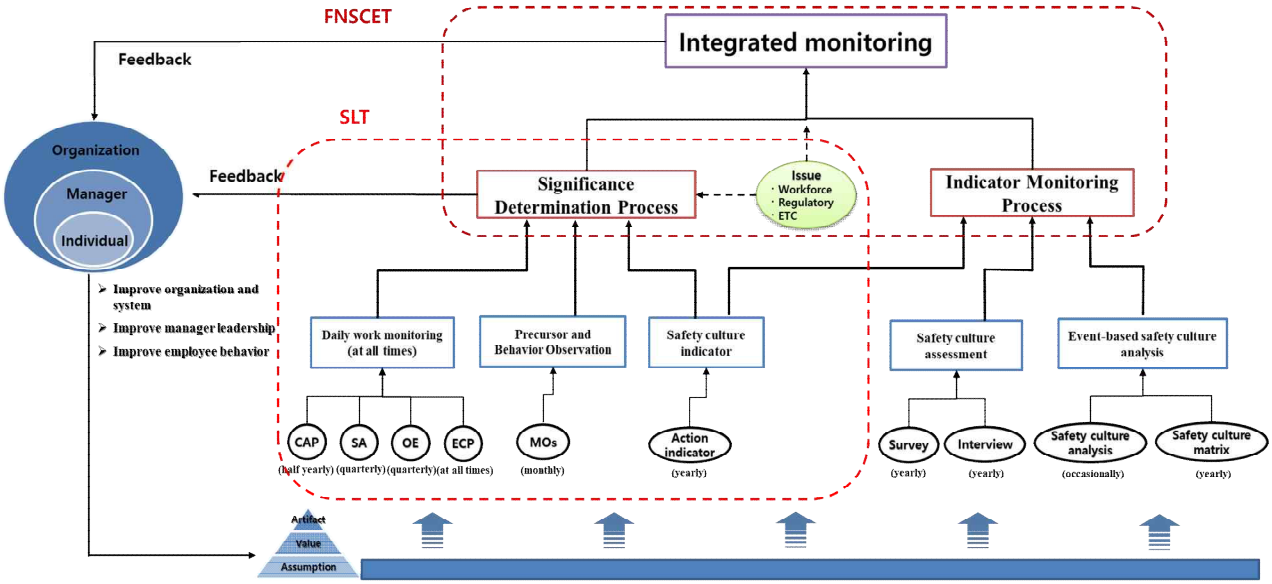

Fig. 1. Nuclear safety culture monitoring process

4. Conclusion

In order for employees to have a healthy safety culture awareness at nuclear power plants, an atmosphere should be fostered in which all members in the organization are constantly concerned about safety and trying to improve themselves. To achieve this, a framework should be provided for employees to discover, easily raise and resolve safety culture issues while performing their duties. However, if the new framework causes unnecessary work and becomes a burden to employees, it will result in a deterioration of safety culture. Therefore, the safety culture monitoring process proposed in this paper will be well established only when operational conditions are created that can be linked to the nuclear power plant's unique tasks. A system should be established in which data such as employee behavior observation, safety culture indicators, and safety culture analysis results as a result of daily tasks can be generated and accumulated. And a way should be established that the safety culture conference can be included or incorporated into the various conferences currently operating at the nuclear power plant. In addition, interview methods to measure the basic assumption of employees and methods to analyze the causes of safety culture for major events of nuclear power plants are required and data on them should be also managed. Finally, the success of this process depends on feedback. The feedback is an improvement on the system, manager leadership and employee behavior. If these improvements are not implemented in a timely manner, the process will eventually be perceived as unnecessary to employees and its function would be failed. A guarantee of improvements will change the basic assumption of employees and contribute to achieving a strong safety culture.

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