A Study on Nuclear Power Plant Near Miss / Low Level Event Management System Analysis and Improvement Plan

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1. Introduction

After the Fukushima nuclear power plant accident, interest in serious accidents has increased significantly. And the prevention and management of serious accidents has become important. Management of Near Miss(A Near Miss is a potential significant event that could have occurred as the consequence of a sequence of actual occurrences but that did not occur, owing to the plant conditions prevailing at the time.[1]) and Low Level Event(A low level event is the discovery of a weakness or a deficiency that could cause an undesirable effect but has not owing to the existence of one(or more) barriers of defense in depth.[1]) that is fundamental in the prevention of major accidents. As numerous significant events illustrate, management failure to capture, understand and remedy LLEs and NMs often foreshadows significant events.[1] Near Miss and Low Level Events provide insight into weaknesses in the defense necessary to prevent higher level events and offer an opportunity to improve safety, production and cost performance.[1]

Recognizing the importance of Near Miss and Low Level Event, domestic and foreign nuclear organizations are continuously recommending management improvement to domestic nuclear power plants.

This study attempted to identify problems and suggest improvement measures by comparing the IAEA Near Miss excellent management standards with the management status of domestic nuclear power plants and survey results for power plant employees.

After analyzing the Near Miss reports of domestic nuclear power plants, it was found that there were many reports that did not meet the definitions presented by the IAEA and KHNP. And it was found that KHNP improved its management system so much that it could be compared with foreign excellent nuclear power plants. However as a result of the survey, it was found that power plant employees were not aware of this and did not know exactly the concept and definition of Near Miss. And it was confirmed that there was a lack of interest in Near Miss and that he had to receive continuous education.

In order to successfully manage Near Miss and Low Level Event, power plant staff should be aware of the importance of management and pay a lot of attention. It should also eliminate a culture of blaming colleagues for mistakes and foster a culture of mature fairness within the company. This will allow nuclear power plant staff to make more voluntary Near Miss reports, learn lessons from accurate cause analysis, and further enhance plant safety.

2. Methods

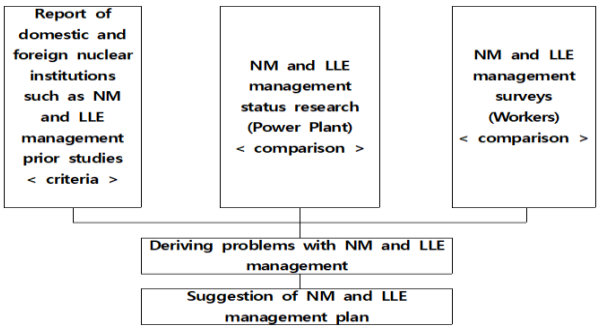

Fig. 1. Process of research and survey.

Fig.1 shows is a schematic diagram of the research process. First of all, in order to confirm the level of excellence in NM management, the 'Best Practices' report prepared by the IAEA and the 'Trending of LLE and NM to enhance safety performance in nuclear power plants' report were studied first. Based on this, the management level was diagnosed by comparing the excellent contents presented by IAEA with the current plant NM / LLE management status, and related contents were surveyed and verified by power plant workers, and problems and improvement measures were derived.

Various statistical data from KHNP's K-HPES system, which are in charge of operating nuclear power plants in Korea, confirmed changes in plant Near Miss reports and the number of reports, and the Korea Institute of Nuclear Safety(KINS). Near Miss management status was investigated through the Central Research Institute(CRI) report and KHNP data. 203 reports were reviewed to see if the NM definition presented by the IAEA and KHNP was properly reflected in the NM report prepared by the worker, and workers were also asked about the NM definition to identify related problems and suggest solution. The survey was conducted on 284 people at Gori 3 power plant and Saeul 2 Power plant, and a survey was conducted on employees of the maintenance department

or power generation department to increase the reliability of the results.

3. Result

2.1 Near Miss / Low Level Event Concept Recognition

Near Miss is an event that 'affected the safety and reliability of the plant' if it progressed to an accident. From 2015 to 2018, 203 reports were re-analyzed by substituting the Near Miss definitions of IAEA and KHNP. Fig.2 shows that there is a large difference in the number of reports by year. A total of 203 Near Miss cases have decreased to 31. The difference in the number of reports shows the possibility that workers are aware of the wrong concept of Near Miss terms, and the number of reports has increased quantitatively, but it is judged that further improvement is still needed in terms of the quality of the report.

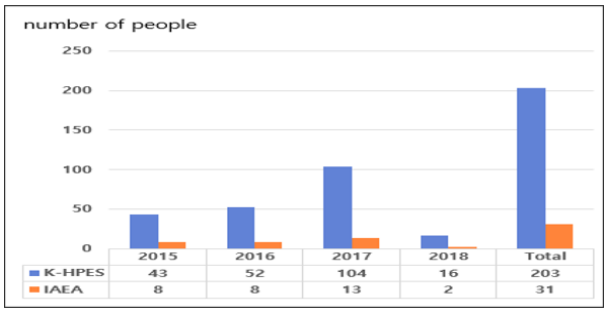

Fig. 2. The difference in the number of reports when the IAEA Near Miss definition is applied[2]

Therefore, in order to ensure that the plant staff knew the concept of Near Miss correctly, a survey was conducted to ask the plant staff the word they thought was most similar to the term Near Miss.

As a result, Table I shows that the percentage of power plant workers perceived as a "Acha-case" was high at 70%, and the percentage perceived as a "Near Miss" was relatively low at 20%. Through this, it seems that power plant employees need clear conceptual training for Near Miss if they are found to be confused about the near Miss term.

Table I: The word is most similar to "Near Miss"

What word do you think is most similar to Near Miss ?	Ratio (%)
Acha Case	70%
Accident proximity case(Near Miss)	20%
I don't Know	5%
Human error	4%
Other opinion	1%
Low Level Event	0%

Since Near Miss is variously defined in a number of procedures of KHNP(Korea Hydro & Nuclear Power), and "Near Miss" and " Acha-case" words are used interchangeably, and industrial safety-related NMs and other NMs are used separately, it is judged to be confusing to workers.

Table II shows the concept of Near Miss by Domestic and International nuclear-related organization.

Table II: Domestic and International nuclear-related organization, "Near Miss" concept [3]

IAEA(International Atomic Energy Agency)
A Potential significant event is defined as Near Miss, where a significant event means an incident means an incident subject to IAEA report.
WANO(World Association of Nuclear Operators)
Not only important events but also their own standards are set to select and report Near Miss cases. This criterion interprets its own WANO reporting target case.
Nuclear Safety and Security Commission
The term ' Near Miss' is used, which can be interpreted as an event that could have led to an accident of INES grad 4 or higher, but did not advance to the accident though any barriers or preliminary matures.
KINS(Korea Institute Of Nuclear Safety)
The concept and definition of IAEA are applied and used as the term 'Near Miss'.

Comparing Table I and Table II, it is confirmed that there is considerable confusion in terms and concepts related to NM and LLE used by domestic and international nuclear-related organization and workers at domestic nuclear power plants. Therefore, it can be seen that it is necessary to organize the concept of Near Miss and related terms that satisfy both domestic and international nuclear-related institutions and power plant workers.

Regulatory agencies and power plants frequently use mixed 'Acha-case' and 'Near Miss'. However, Table I shows that nuclear power plant workers perceive 'Near Miss' from 'Acha-case' differently. In order to confirm how workers perceived 'Acha-case' and 'Near Miss' diffently, a survey was conducted by applying the CAP grade. As a result, power plant workers responded with grade 3,4 for 'Acha-case' and grade 2,3 for 'Near Miss'.

Fig 3. shows that nuclear power plant workers perceive 'Near Miss' as a higher grade than 'Acha-case'.

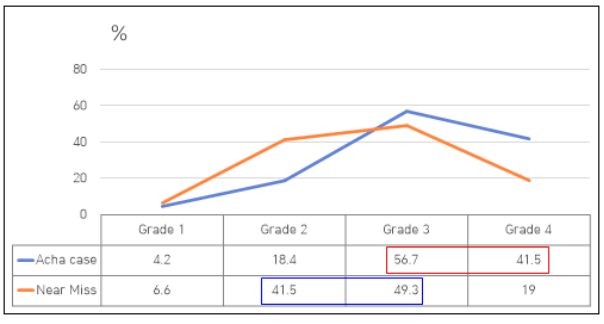

Fig. 3. By applying the CAP grade, classification of 'Near Miss' and 'Acha-case'

2.2 Suggestions for concepts model that are easy for workers to understand

Through this study, it was confirmed that power plant workers were confused about Near Miss, Acha-case, Low level event terms. Workers should be accurately aware of the concepts of Near Miss, Acha-case, Low level event. Because accurate reporting is possible and cause analysis by level is possible.

It is intended to present a model that enables the nuclear industry to accurately and easily recognize the concepts of Near Miss, Acha-case and Low Level Event.

Fig 4. is a model that summarizes the concepts of Near Miss-related terms by reflecting the perception of nuclear power plant workers, consistent with the concepts presented by domestic and international nuclear institutions.

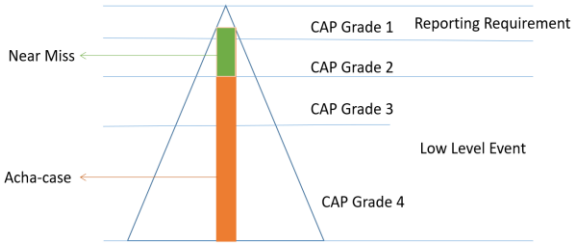

Fig. 4. By applying the CAP grade, 'Near Miss' and ' Acha-case', 'Low Level Event' relationship model

In this study, I would like to redefine the concept of the subsequent case as follows.

- Acha-case : All events that did not affect plant safety and reliability due to appropriate measures or barriers. **(CAP grades 1 to 4)**
- Near Miss : Unstable conditions(technical and organizational factors) or behavior(human factors) almost affected plant safety and reliability. An event that did not affect the safety and reliability of the plant due to appropriate measures or barriers. **(In the case where potential result falls under CAP grades 1 and 2)**
- Low level event : There is no serious problem due to the presence of one or more in-depth barriers, but cases in which vulnerabilities and deficiencies that may have undesirable effects were found. **(including Acha-case of CAP grade 3 and 4)**

2.3 Factors that interfere with Near Miss reporting

In this study, in order to confirm the factors that hinder reporting of the case of the power plant workers, a questionnaire was conducted on what the reason would be if the person who experienced the case of the case of the error did not report.

Table III shows the results of the response ratio to "what ate the things that hinder Near Miss reporting" for power plant workers.

'If I report it, I have to take action' response was the highest at 46.8%. Similar content, 'I have a lot of work to do. I don't have time.' response was confirmed to be the third highest at 35.9%. 'I'm afraid I'll get laughing, criticizing(repriming)' response was the second highest with 38.7%. This shows that there is still a culture of criticism for human mistakes in nuclear power plants. 'I Don't know the reporting system, process' response was confirmed to be the fourth highest at 24.3%. It has been confirmed that one in four nuclear power plant supports does not know the systems and processes related to Near Miss, so it is considered urgent to develop an educational program for this.

Table III: Factors that interfere with Near Miss reporting(Result of survey)

Questions	Ratio (%)
If I report it, I have to take action	46.8
I'm afraid I'll get laughing, Criticizing(repriming).	38.7
I have a lot of work to do. I don't have time.	35.9
I don't know the reporting system / process.	24.3
Since there's no accident.	21.5
Since anonymity is not guaranteed.	20
Since people don't expect it to improve.	15.8
Since people don't use it often.	5

Since the maintenance department and the power generation shift department of nuclear power plants have different working patterns and different organizational cultures, it is necessary to check if there are any differences in hindrance factors.

Table IV: Factors that interfere with Near Miss reporting by department(Result of survey)

Questions	Maintenance department (%)	Power Generation shift department (%)	overall (%)
If I report it, I have to take action	53.68	44.36	46.8
I'm afraid I'll get laughing, Criticizing(repriming).	27.36	48.12	38.7
I have a lot of work to do. I don't have time.	45.26	31.57	35.9
I don't know the reporting system / process.	31.57	17.29	24.3

Table IV shows that the factors that hinder Near Miss reporting perceived by the maintenance department and the power generation department were quite different.

In the maintenance department, 'If I report it, I have to take action.' Response was 53.68%, and 'I have a lot of work to do. I don't have time.' response was 45.26%, which was quite high. And 'I'm afraid I'll get laughing, criticizing(repriming)' response was 27.36%, which was found to be significantly lower than that of the

power generation shift department. This is judged to have a significant burden on the increase in work due to the higher intensity of work compared to other department, and it seems that there is less culture of criticizing among employees due to the high intensity of work. On the other hand, in the case of the power generation department, 'I'm afraid I'll get laughing, criticizing(repriming)' response was the highest at 48.12%, and I don't know the reporting system process was 17.29%, which was significantly lower than that of the maintenance department. In the case of power generation operators, the burden of mistakes seems to be high because a single human error has a significant effect on the safety and reliability of power plants. On the other hand, it is estimated that the awareness of systems and processes is quite high, which seems to be due to the opportunity to receive a lot of Near Miss education class.

2.4 Voluntary Reporting Method (Results of survey)

In order to fine a way for the absolute majority of nuclear power plant workers to think, a questionnaire was designed and implemented so that they could make duplicate choices with possible content by referring to the current plan used by the power plant and IAEA best Practice.

As a result, Table V shows that power plant employees think of eliminating the culture of criticism within the organization, forming a dedicated organization to reduce the burden if reporting, and providing education on system or processes for many employees. In addition, currently, power plants reflect the number of Near Miss reports in the internal evaluation of power plants to induce Near Miss reports to power plant workers. However, as shown in the survey results, the refection of the internal evaluation of the power plant was found to be inappropriate as a way to voluntarily report well.

Table V: The best way for workers to voluntarily report(Result of survey)

Answer	Ratio (%)
If the culture of criticizing improves (if not punished)	53.87%
As long as the dedicated organization solves all the analysis and corrective measures, and reporter is in charge of reporting	50%
If the reporting system/process guidelines are well shared	36.97%
If you see it being used well	21.83%
If you get a prize like a gift certificate	16.90%
If it is reflected in the internal evaluation of the nuclear power plant	4.2%
the others	3%

4. Conclusions

If a single major accident can be prevented though the successful management of Near Miss and Low Level Event, it will contribute to national development as well as meet the expectations of the people. It was confirmed that nuclear power plant workers did not recognize the exact concept of Near Miss. The Near Miss management system and process have recently made remarkable improvements compared to advanced overseas power plants, but it has been confirmed that not many employees have actually used them, and it has been confirmed that education and promotion are not good for users. Although KHNP managers encourage plant workers to report well even if they make human mistakes, it has been confirmed that there is still a culture of criticizing among nuclear power plant workers. In order to solve the problem, it should be a top priority to organize clear concepts and terms for Near Miss that power plant workers are confused and using and make it recognized by all power plant workers. It is necessary to continuously provide customized training for power plant workers and managers and create an organization dedicated to safe operation processes.

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