

## Influence of Nuclear Safety Culture on Incident History of Nuclear Power Plants in Korea

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### 1. Introduction

Nuclear Safety Culture is “that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear power plant safety issues receive the attention warranted by their significance.” This term first appeared in the report of the IAEA after the Chernobyl accident in 1986. With this accident, the importance of safety culture has been paid attention and international consultations have been sought to promote nuclear safety culture.

According to a series of researches on the safety culture, it was observed that a lot of incidents or accidents caused by human factors that influence the safety of nuclear installations over all phases, including design, construction, commissioning, operation, maintenance and test. The phrase “human factors” is used to describe the interaction of individuals with each other, with equipment and facilities and with management systems. It also is used as interactions are influenced by a work environment and safe working culture.

Reviewing incident reports of IAEA (IRS) reveals that human factors caused incidents or accidents. Accidents can generally be attributed to one of three actions: human errors and unintentional mistakes, poor judgment and bad decision making and disregard for procedures. Therefore, the human factors identified in the incident or accident histories became an influence factor of safety culture because attitudes/negligence and perceptions of workers, and organizational practices, were revealed as the root cause or precursors that caused the incidents or events.

The aim of safety management of nuclear power plants is to intervene in the accident causation process and to prevent or detect failures in the process of hazard identification, control and monitoring. According to the feedback from a series of researches on the safety culture, the human factors, particularly the rate of human error for the incidents, were revealed as the root cause or precursors that caused the incidents or accidents as a major influence factor of safety culture in the incident or accident histories. Moreover, even due to the lack of safety culture were also observed as a major factor that increased rating generally in the Nuclear Event Scale (INES) reports.

Thus, the safety management for the safety culture including human factor is important not only to prevent human errors but also to foster and support a strong

safety culture through the development and reinforcement of good safety attitudes and behaviour in individuals and teams so as to allow them to carry out their tasks safely. Hence, this study focused on investigation of influence of human factors and safety culture on incident history of nuclear power plants in Korea in order to identify a direction for the future strategy of enhancing safety culture.

### 2. Influence of Human factors on Incident History

In the light of the Fukushima Daiichi accident, there have been attempts to include safety culture in the safety regulations and facilitated its implementation as a follow-up measure to the all loss of AC power called a Station Black Out (SBO) occurred in 2012 at Kori Unit 1. This incident was motivated to promote safety culture have been selected as a key task, “Establishment of a safety-first management system for business operators and spreading a safety culture” in the 1st Comprehensive Plan for Nuclear Safety (‘12~‘16). The safety culture was to be a key predictor of safety performance so that the safety culture of an operational

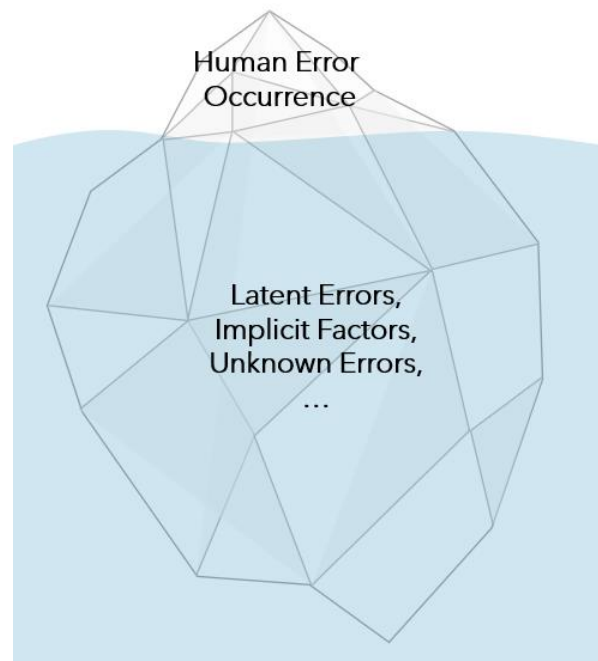


Figure 1 The Characteristic of Human Errors

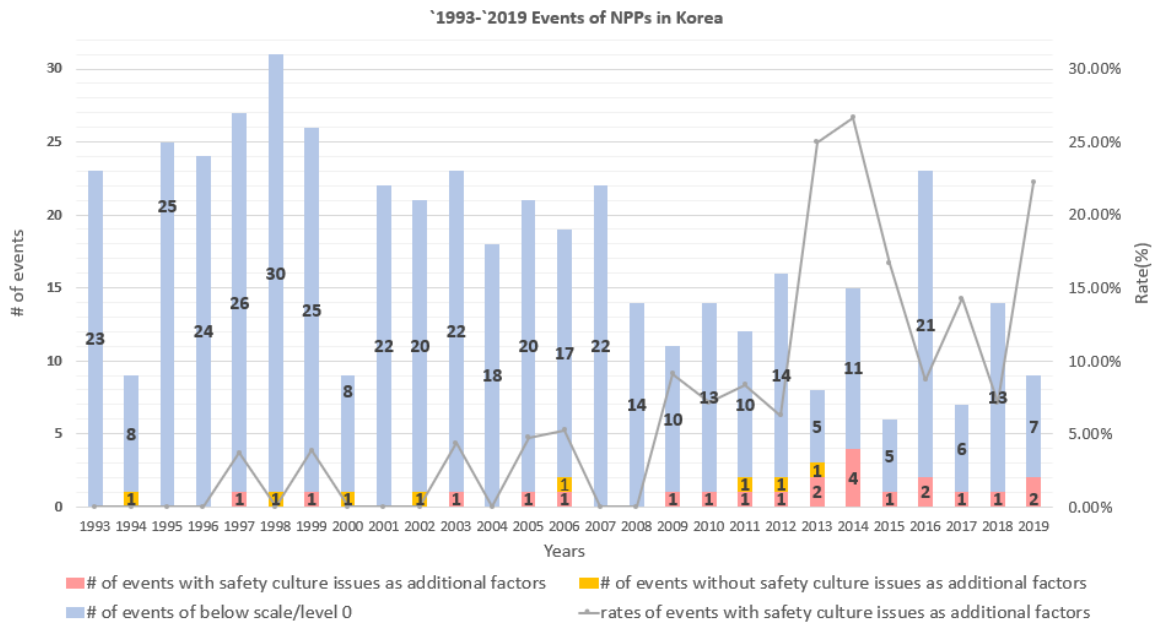


Figure 2 1993-2019 Trends of Events of NPPs in Korea

organization is essential to the attitudes of personnel in the organization. Indeed, human factor, a sub-set of the overall organizational safety culture (for example attitudes/negligence and perceptions of workers, and organizational practices) may have more influence on incident or accident rates than many elements of mainstream safety management in nuclear power plants. Since nuclear power plants are designed, constructed, and operated by humans, most incidents or accidents failures that occur probabilistically, have a part contributed by human factors in a broad sense. In particular, inadequate quality assurance activities continue due to the lack of a safety culture, and this can potentially contribute to equipment failure, but in most cases it is revealed as inappropriate behavior of the accident trigger. This is because the lack of safety culture appears as a human error or attitude/negligence, and since human error has the characteristic of potential representation (Figure 1), it must be approached from the viewpoint that one revealed error represents a number of undisclosed errors.

As a result of trend analysis on the cases of human error occurring in domestic nuclear power plants conducted by Korea Hydro and Nuclear Power (KHNP), it was found that the main causes of major and minor cases were mostly coincident. This suggests important implications when analyzing cases related to human error and safety culture. Contributions may differ for each factor representing the safety culture to the potential cause and effect that the lack of safety culture leads to unsafe behavior. Currently, as a countermeasure for safety culture, a strategy is being used to derive weak elements related to safety culture from incidents or cases and prepare an improvement plan.

### 3. Influence of Safety Culture on Nuclear Power Plant Incident/Accident Ratings

Korea Institute of Nuclear Safety (KINS) discloses all accident and failure data reported by nuclear power plant operators in accordance with the reporting regulations [Nuclear Safety Committee Notice No. 2020-3] through Operational Performance Information System for Nuclear Power Plant (OPIS). The trend of accidents in domestic nuclear power plants published in OPIS was analyzed.

Nuclear event data provided by Operational Performance Information System of nuclear power plants (OPIS) discloses the grade determined according to the International Nuclear Event Scale (INES) system. INES was developed by the IAEA in 1990 and began to be used in earnest from 1992 after pilot application. The INES rating system has been introduced and utilized since 1993 for domestic nuclear power plants. According to the INES rating system, the basic accident rating is determined according to the incident information, and if there are additional uplifting factors (Common Cause Failures, Procedural Inadequacies, or Safety Culture issues), the raising of rating is considered. Incidents or accidents of domestic nuclear power plants were investigated by KHNP (see Ref. 2) and was observed that increased rating generally caused due to the lack of safety culture.

The Figure 2 shows the trend of safety culture related incidents or accidents and breakdowns of nuclear power plants that occurred from 1993 to 2019 in Korea. In Figure 2, it was observed that safety culture-related factors have increased in recent cases compared to the past. It showed that while the total number of incidents or accidents has decreased as more recent years come, incidents of grade 1 or higher grades have occurred

continuously every year. It is also seen that the proportion of incidents or accidents with an increased rating due to in safety culture is on the rise. However, this does not directly imply that the current nuclear power plant workers lack a safety culture compared to the past. In other words, there have been changes in the regulatory supervision environment and system for safety culture-related factors since the early 2010s. Hence it could be difficult to directly compare the root cause or precursors that caused the incident or event rating evaluation from 1993 to 2019 so that it is needed that human/organizational factors and safety culture-related factors should be carefully re-examined. It is also difficult to observe the level of promoting safety culture in a short period of time because the safety culture requires long-term follow-up change observation, but for that reason, it is important to grasp the current level and prepare realistic measures to improve the level of safety culture and continuously promote it.

#### **4. Conclusions**

This study conducted on investigation of influence of human errors and safety culture on incident or accident history of nuclear power plants in Korea aimed to identifying the root causes or precursors that contributed to the incident or event and concluded as followings:

- As a result of trend analysis on the cases of human error occurring in domestic nuclear power plants, it was observed that the main causes of major and minor cases were mostly coincident.
- The trend of safety culture related incidents or accidents showed that while the total number of incidents or accidents has decreased as more recent years come, incidents of grade 1 or higher grades have occurred continuously every year. However, since there have been changes in the regulatory supervision environment and system for safety culture-related factors since the early 2010s, it could be difficult to directly compare the root cause or precursors that caused the incident or event rating evaluation for given period, 1993-2019
- It is needed that human/organizational factors and safety culture-related factors should be carefully re-examined.

In conclusion, since the safety culture requires long-term follow-up change observation, it is important to grasp the current level and prepare realistic measures to improve the level of safety culture. Moreover, in order for measures to improve safety culture to be practically effective, it is suggested that a step-by-step and strategic approach must be taken. By deriving the priority of the relative importance to the safety of nuclear power plants by elements of safety culture and establishing a strategy according to the priorities, it will have a greater effect on safety improvement.

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