A Study on the Improvement of the Classification System for Nuclear Events

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1. Introduction

The license reports the event occurred in nuclear facilities including commercial nuclear power plants (NPPs) to both the Ministry of Science and Technology (MOST) and Korea Institute of Nuclear Safety (KINS) according to Notification No. 2001-44 of the MOST. The objective of investigation and reporting of the causes of the event by KINS is the identification of the corrective actions which are adequate to prevent recurrence, which protects the health and safety of the public, the workers, and the environment.

The investigation process in the field is used to obtain an understanding of the event, its causes, and what corrective actions are necessary to prevent recurrence. The process includes the following phases: collection of the data, identification of problem, determination of the significance of the problem, identification of the causes (conditions or actions) immediately preceding and surrounding the problem, and identification of the reasons why the causes in the preceding step exist, working back to the root cause. Through the process, the effective corrective actions for each cause are establish by KINS and implemented by the utility.

The investigation report on the event is made to include the investigation process and corrective actions and thereafter is sent to the MOST. The report, which is categorized with the classification system for the nuclear events, is also managed as the basic data in the Operational Experience Feedback System (OEFS) and opened to the public through the OPIS web-site (Operational Performance Information System for NPPs, http://opis.kins.re.kr). In other words, the reports have to be classified to find the reflection item in the nuclear safety regulation through analyzing the past events and to help the public understanding with the nuclear events. Consequently, the classification system for the nuclear events is necessary to be in detail for the experts and to be simple for the public.

2. Current Classification Systems

2.1 KINS Classification System

Both the KINS classification system and the Incidents Reporting System (IRS) operated by IAEA/NEA described in next paragraph have been used as the classification system for the nuclear events in KINS. According to the system developed in KINS, the events are classified by the following bases.

Where happens the event?
1 The event occurred in primary system including primary reactor systems and essential reactor auxiliary systems
2 The event occurred in secondary system including essential service systems, essential auxiliary systems, electrical systems, feedwater, steam and power conversion systems, and so forth

What causes the event?
H The event caused by human error
M The event caused by mechanical defect or failure
C The event caused by defect or failure of instrumentation and control system
E The event caused by defect or failure of electrical system

This system has the advantage of a simple and easy tool to categorize the event. In OEFS, however, there are some problems to analyze the root cause with unclear and obscure definitions.

2.2 Cause Categories of IRS operated by IAEA/NEA

The Incidents Reporting System (IRS) is an international system jointly operated by the International Atomic Energy Agency (IAEA) and the Nuclear Energy Agency of the Organization for Economic Development (OECD/NEA). The fundamental objective of the IRS is to contribute to improving the safety of commercial NPPs which are operated worldwide. This objective can be achieved by providing timely and detailed information on both technical and human factors related to events of safety significance which occur in these plants. The cause categories in the IRS include:

5. Cause of the Event
   5.1 Cause
      5.1.0 Unknown or other
      5.1.1 Mechanical failure
      5.1.2 Electrical failure
      5.1.3 Chemical or core physics failure
      5.1.4 Hydraulic/pneumatic failure
      5.1.5 Instrumentation and control failure
      5.1.6 Environmental (abnormal conditions inside plant)
      5.1.7 Environmental (external to the plant)
      5.1.10 Human factors
   5.3 Inadequate human action – plant staff involved

5.4   Inadequate human action – type of activity

5.5   Human performance related causal factors and root causes

5.6   Management related causal factors and root causes

5.7   Equipment related causal factors and root causes

The events classified with these categories are easy for the experts to understand completely and to search according to the causes. However, it is too difficult to categorize the events according to the system. The meaning of the classification results may be insignificant in a small number of nuclear events.

2.3 Cause Codes used in Root Cause Analysis of U.S. DOE

U.S. Department of Energy (DOE) requires the investigation and the reporting of events including the performance of root cause analysis and the selection, implementation, and follow-up of corrective actions. The level of effort expended should be based on the significance attached to the event. Most of the off-normal events need only a scaled-down effort while most of emergency events should be investigated by using one or more of the formal analytical models. In many of the root cause analysis models, the direct cause, the contributing causes, and the root cause of the event are categorized with the cause codes shown in Table 1. The categories in Table 1 are consist of 2 ~ 6 subcategories.

Table 1. Cause Codes of U.S. DOE

Problem/Deficiency Category		Direct Cause	Root Cause	Contributing Cause
Operational Readiness Problem	Equipment/ Material Problem			
	Procedure Problem			
	Personnel Error			
Management/ Field Bridge Problem	Design Problem			
	Training Deficiency			
Management Problem				
External Phenomenon				

3. Improved Classification System

The new improved the classification system is characteristic in the followings:

●   The system is based on the concept that the event occurs only in the nuclear installations to be maintained and influenced by the operational management.

●   A failure of the installation can be subcategorized by the problem in design/manufacture, in aging, or in transient. (see Table 2.)

●   The event by external environmental effect is classified by other cause code.

●   Both the root cause and the direct cause of the event can be categorized.

Table 2. Improved Classification System

	Mech. Comp.	I&C Comp.	Elec. Comp.	Operational Management
Design/ Manufacture Problems	MD	CD	ED	-
Aging Problem	MA	CA	EA	-
Malfunction/ Damage in Transient	MT	CT	ET	-
Organization Problem	MO	CO	EO	O
Human Error	MH	CH	EH	H

4. Conclusion

The improved classification system for the nuclear events has the consistency with the current KINS classification system, the simplicity and clearness for the public to easily understand, and the subcategories for cause analysis in OEFS. To verify applicability and practicability of the improved system, both the direct causes and the root causes for more than sixty events including reactor trips and engineered safety features (ESF) actuations in the last three years have been analyzed. The result of the analysis comes to the conclusion that it is a useful classification system to find not only the weak nuclear installations but also their failure causes and at the same time the root causes.

REFERENCES

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