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A System Engineer's Perspective on Human Errors For a more Effective Management of Human Factors in Nuclear Power Plants

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1. Introduction

The management of human factors in nuclear power plants (NPPs) has become one of the burden factors during their operating period after the design and construction period. Almost every study on the major accidents emphasizes the prominent importance of the human errors. Regardless of the regulatory requirements such as Periodic Safety Review, the management of human factors would be a main issue to reduce the human errors and to enhance the performance of plants. However, it is not easy to find out a more effective perspective on human errors to establish the engineering implementation plan for preventing them. This paper describes a system engineer's perspectives on human errors and discusses its application to the recent study on the human error events in Korean NPPs.

2. Human Error Studies in Nuclear Domain

2.1. Approaches to the Human Error Management

Nowadays, human errors have become afford to get more attentions in the aspect of the technological liability as well as the safety, performance and efficiency. There are too various methods and approaches to the human error studies. HRA, HPES, PSR, HFEPP, HFMP and other models and programs are the currently on-going and developing efforts in nuclear domain. However, it still is not easy to catch out the most effective one for the shake of industrial application. Blunt trials without more careful technical criteria could be out of the ultimate goal of human error studies, i.e. the recurrence prevention, in spite of their sincere devotions for the causal investigation and the fairly long struggling processes.

Professor Rasmussen had elucidated that a paradigm on human errors should shift from the existing perspective such as the scientific, common-sensed, and attorney's one to more effective one. Dr. Reason, a psychologist, also describes the human error as an accident rather with the so-called Swiss Cheese Model than a cognitive mechanism of the human fault. Human errors are turned out to be more than human fallacies, such as slips, blunders, fumbles, and violations, and management of them should be extended to the behind of human himself. He discriminates the system approach from the person approach in error management. Error management can be focused to a few different goals for the system safety. It is indispensable to specify which is the real purpose of the human error analysis at the first.

At first, the goal can be established to the prevention of human fallacy. Erroneous actions need to be treated. During the pursuit of this goal, blaming to human is familiar and inevitable for resolving the responsibility to the consequences of the human error event.

Secondly, the goal can be diverted to the prevention of the events induced by the human involvements. Many surrounding components constituting the event can be considered as the possible means to prevent the triggering the initiating precursors and to stop their propagations to the consequences of the event.

Thirdly, the undesirable consequence to be resulted from the human-related events may be the ultimate goal of the human error management. In this perspective, human error itself may not the main concerning on the consequence of the event.

2.2. Characteristics of Human Errors in Practice

Academic theories cannot provide the human error mechanisms and their nature enough to explain an agreeable strategy to prevent its recurrences in the future. Followings may be a set of axiomatic statements for the human error studies and managements generally accepted by the practitioners in industries;

1. Human error in an accident occurs by Accident.
2. Human error can be captured by the Statistics.
3. Human error is to blame to Human.
4. Human error can be reduced by Enforcements.
5. Human error can be reduced by Voluntary Efforts.
6. Human error never recurs to the Same Human.
7. Human error can be prevented by eliminating Causes.
8. Performance also means Safety.
9. The Same Cause, the Same Accident.
10. Keep the Basic Principles against Human errors

However, above statements turned out to be myths that may sometimes confuse to obtain the good counter-measures in practice. The limitations and the exceptional counter-arguments were discussed by the occasional experiences during the various analysis and management of human errors. Sometimes the industrial programs for the human error management have turned out not to be fruitful comparing to the multifaceted efforts that are frequently poured after the bitter experience of human errors. The practitioners in those cases frequently adopt above common-sensed myths without further considerations. There needs a new perspective to overcome these myths on human errors and their studies.

3. A more Effective Perspective for Engineering

More careful considerations according to the previous discussions about the myths on human errors can change the basic perspectives applied to the human error studies, and the fundamental understandings may be described as following arguments. These never mean new findings about human errors conceptually, but give fairly beneficial points to the human error studies in practice.

3.1. Dependency of Human Error

The analysis of human error has the true meaning when it is coupled with the conditions and behaviors of the failed system in an accident. It may not be understandable why a human behavior is an error in an accident if it is reviewed independently. It is not easy to conclude the operator action to an error if the action is not reviewed with the entire system which he or she has been involved. The judgment of an error or not is determined depending on the whole system behaviors and surrounding situations. Many analysis reports including human errors are describing focused on only the human behavior itself. Therefore the existing documents of human errors do not provide enough information to improve their performance. Also, there is a tendency that because only one or two key factors are regarded and analyzed as the cause of an accident, the other tedious issues and information are ignored or buried in the accident.

3.2 Representative-ness of Human Error

When an accident occurs, it means that the possibility of other similar accidents is hiding like the sub-water part of an iceberg. The latency of accident is depending on the type and complexity of the system. The more complicated system has the bigger latency of accident. Therefore an occurred accident is the representative case of the other lot of hiding accidents in the system. The multiple barriers and redundancy structure of NPPs covers most of failures under the blanket. In the human error analysis, such latency and representative nature should be carefully addressed particularly for NPPs. When an human error event is reviewed, it is essentially necessary to identify the in-depth structure of the event and to look at every influencing factor around it. The result to the events should be representative for all the similar events that might be happen in the system

3.3 Structured-ness of Human Error

Human error should be apprehended based on whole system behavior, which can be captured with multiple stages in terms of factors related to the system. By so-called domino theory in safety engineering, accidents may occur in five stages such as environment -> human deficiency -> unsafe acts or unsafe states -> accidents -> injuries or damages. Therefore, the analysis of human errors intends to foresee the internal mechanism and latent effects of accidents rather than the superficial contents. Also, it can be known that the composition of causes in the analysis of accidents should have a broad structure in sense of chain reaction and multi-stage properties of accidents. An important thing is that in order to prevent accidents we should pay attention to valuable information from a near-miss and consider it as an opportunity to recognize as much as the possibility of latent effects from the internal mechanism of accidents. To prevent accidents, we should have an overall set of causes related to possible countermeasures.

4. Application to the recent human error events

We apply the proposed perspective to the re-visit study of the human error events which have been occurred recently in operating plants and reported in the KINS web site, named by OPIS (~~http://opis.kins.re.kr~~). Originally, every case has the formal report(s) including fairly small number of the causes and the counter-measures. Although a management plan could be suggested based on the statistical analysis of the causal factors described in these reports, the level of statistical significance is still not enough due to the lack of data.

A wider range of influencing human factors can be obtained through the application of the proposed perspectives. The influencing human factors may not be the direct causes of the corresponding event, but be the beneficial counter-measures. Almost 10-times of plausible counter-measures from the revisit of the events have been obtained comparing the original reports. It can give another kind of remedial recommendations with the stronger significance enough to establish a more concrete plan for the human error prevention.

5. Conclusions and Discussions

Various efforts have been applied to the human error managements, in which different perspectives on human errors might be incorporated in NPPs. A specific perspective from the system engineering was proposed for the more practical implementation setups to reduce the number of human errors in NPPs. With a case study, we conclude the proposed perspective can provide more effective information to the human error management.

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