

A Scrutinized Step Proposed to More Effective Human Error Investigations for including Violations and their Countermeasures

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1. Background

In 21-st century, concerns are growing over the vulnerability of technology. While drastic advances have highlighted the intelligence and hyper-connectivity in ICT technology, new vulnerabilities have also been increased as both safety and security concerns to people. It may not be just a matter of nuclear power that has recently been emphasized in various fields. [7]

New kinds of efforts for the different level of safety are also required in the nuclear power sector due to these technological developments and changes. Traditional efforts for safety can be divided into pre- and post-measures, and retrospective analysis of events that have already occurred during traditional follow-up measures has been emphasized as a key to the safety in practice [4]. The results of follow-up countermeasures, such as retrospective analysis, must be closely linked to prior/proactive actions in the pre-measure [8, 9]. A retrospective analysis is to derive useful information for proactive action from safety-related events.

The most uncertain part of retrospective analysis is frequently, however, related to human errors. This is because human error is neither determined nor visible to the extent and the causality of many influencing factors. Therefore, very few designs have been proven to be sufficiently prepared for the possibility of human error.

A traditional way to prepare for human errors is to reduce the problems of causal factors by continuous feedback of the analysis results of the correct cause of the error in post-analysis. Thus, in retrospective analysis of events, the approach to human errors is key to determining the usefulness and effectiveness of the event investigations and their results.

2. Human Errors and Their Investigations:

2.1. A Brief on Human Error Analysis

I reviewed most traditional approaches and methods for human error investigation and analysis in theory and practice, and found one curiosity about the basic concept applied to them. Human error analysis has been misunderstood as an investigation on human error itself rather than on an (or failure) factors related to human error. Causal analysis needs to be focused to the human factors as well as human himself.

2.2. Analysis for the Causes and Countermeasures

After discussing the limits of traditional approach to human error event investigations, it may be concluded that we need to go beyond those causal analysis for the Safety in 21-st Century. During the most human error event investigation, the causes have been top-priority over the countermeasures.

Traditionally, causes have been treated as more important than countermeasures. Sometimes, when the cause was determined, measures were already considered automatic. (i.e., the countermeasure has been believed to simply eliminate the cause.) However, the measure is different from the cause, and the process of establishing the measure requires a variety of considerations on a completely different level.

In the case of human error, it is very difficult to detect the cause. However, it is often more difficult or almost impossible to actually eliminate elements captured as the cause of human error through difficult root cause analysis. Selecting a countermeasure will require additional considerations related to the effectiveness of the countermeasure as well as the feasibility.

By accepting the notion (*Human Error 2.0*) that the cause of human error is related to the characteristics of a given work environment and surrounding system components, not to the human self, in the accident analysis, a significant improvement in human factors engineering was achieved. However, a variety of emerging human errors are not enough to be addressed by the concept of *Human Error 2.0*. Among them, violation errors are very difficult to analyze and select countermeasures. The most frequent obstacle to the analysis of the cause of human error is the risk of being sunk into the simple conclusion that the cause (analysis) is the problem of the person involved and his responsibility and safety culture. However, the risk of this misinterpreted analysis is often almost automatic in violation-type human error. This is because a violation means a conscious violation of what is set and given.

The notion of *Human Error 3.0* [7], other challenging concept on human error safety such as Safety II [2], resilience, and *Normal Accident* have been proposed to enhance the limits of traditional approaches to human error investigations.

3. A Scrutinized Step Proposed to Human Error Investigations including Violations

3.1 Complementary Steps for Violation Investigations

There is a possibility that many human errors can be judged to be violations. However, when it is mentioned as a violation of human error, it is likely to be treated as if it is not approaching the possibility of technical supplementation. Therefore, a carefully adjusted approach would be required for human error investigation analysis considering violation-type human error. The notion of *Human Error 3.0* can provide a foundation to enhance the current approaches to go beyond the causal analysis to countermeasure-centered analysis. A key objective of a prudent approach is to ultimately obtain more effective countermeasures. This means that new efforts are needed to overcome the limitations of traditionally transitioning to discussions related to responsibility and punishment.

3.2 Categorization of Violation for Investigations

Various new types of violations are raised from the human error studies [3,5,6,14]. Sometimes test-purpose and asked/induced violations matter as *after-event* issue. Mannerism, negligence, avoidance,[11] and *Organized Irresponsibility* [10] are also reported as important violations. They may go beyond the routine/permitted, optimized/convenience, temporal/exceptional violations.

A study describes a new categorization of violations to give a more details on the types and causes of them. However it may be beneficial that the causal analysis go just behind the countermeasures selectable. A reciprocal approach to causes and countermeasures is proposed.

3.3 A Scrutinized Steps to Violations

Categorization itself may give benefits to figure out not only the causes of violations but also the countermeasures to them. Violations in human error investigations gives rise the concerns of responsibility understood with a repent, and can be described as a pass over the rules given and criteria required. Frequent analyses have focused to the responsibility, and applied to blaming rather than coping with them. It frequently blames to sharp-end people just involved in the event. A substitution test logic ([15] revised from [1,5] Reason & Govaarts in HERA-JANUS) may help to discriminate the ‘honest error’ for the culpability of violations.

The objectivity may be vague and strongly dependent on the judicial investigations rather than any causal and technical one. When detailed works on violations are required to their culpability, further categorization and substitution test of violations can be applied by incorporating the criteria of intention, perception, and management [15]. However countermeasures should be prioritized to causes if we want to cope with human error rather than just blame the responsible people [16].

Countermeasure can be devised by virtue of available technical resources and selected through perspectives including traditional cost-benefit analysis and other decisions. Three-layered approach consisting functional, behavioral, and culpability layers is proposed to specify

the rationality of countermeasures in addition to causes during investigations. Culpability is tested after function assignments and weighted separately to its worth to countermeasures. It can work for human credibility in security and insider threats that may slightly differ from the traditional approach to human errors.

4. Conclusions

In this paper, a more effective method is proposed in post-retrospective investigative analysis of events involving (expected to be involved) human errors. Firstly, approaches of human error were briefly reviewed. Secondly, enhancements to human error analysis methods were sought in terms of effectiveness and practicality as well as including emerging types such as violations. Finally, complementary steps are proposed for human error analysis including violations. It can be applied as an additive regulatory requirement to current human error event investigations [12,13,16].

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