A Preliminary Study on the Culpability of Violation Errors in Nuclear Events and their Investigations

Lee Yong-Hee
Severe Accident Monitoring & Management Research Team, Korea Atomic Energy Research Institute
Daedeok-daero 989-111, Daejon, Korea, 34050
✉ yhlee@kaeri.re.kr

1. BACKGROUND

Previous recent several studies on human errors in nuclear reveal a demanding research topic on violation type errors [2018/2019/2020 Lee]. Violation errors should be considered additionally during various human factors safety assessments such as HRA (human reliability analysis) and V&V (verification and validations) of design and severe accident management strategies as well as within human error event investigations, PSR (periodic safety review), Stress Test, and their back-fittings.

This high-reliability era is demanding a different level of safety. The expected technical advances resulted into the super-connected-ness and rather more vulnerability (2018 Lee). Nuclear itself has revealed very unique and hard-to-overcome characteristics for system safety. (2015, 2016 Lee)
- large and complex system into a social disaster
- non-injury system loss with low self-motives
- latent hazards by multiple barriers and DID
- rare data for learning from errors
- tightly-coupled but delayed risk
- out-of-loop by the partial automation/integration

People is expecting the safety as a feeling of rather wholistic security without uncertainty rather than simple completed functional performances. However the human errors including violations still remain the basic uncertainty to nuclear safety. Violation especially might be a typical types of erroneous performance to be happened in “unprepared” scenarios, “unknown-unknown” risk, and fundamental surprise in unexpected situations described in Fukushima report (2015 IAEA).

This paper describes a preliminary study on the violation type human errors and their treatments during human error event investigations in nuclear. The first and most basic issue of violation is about how to cope with the culpability, and an approach is proposed with multi-layered framework and human error 3.0 concept(2015/2019 Lee) for enhancing the human error investigations in nuclear.

2. VIOLATIONS UNDER A SAFETY CULTURE ISSUE IN HUMAN ERROR INVESTIGATIONS

The human error event investigation systems such as ACRS, HPES, HPIP, HFACS, etc. may have a traditional typical approach to human errors. The traditional human error investigations have adopted a classification on human failures to be included in event structures. Many classifications and taxonomy on human behaviors have been developed. Various criteria such as consequences, human behavior and/or system function, and causal and/or influencing factors can be adopted to discriminate the different characteristics of human error events.

The types of violations such as routine/permitted violation, mannerism, negligence, avoidance, optimized and convenience violation, temporal and exceptional violation, test violation, after-event violation, asked/induced violations could be examples found in recent revisit to human errors. Influencing and causal factors can characterize violations. Recent proposal to the house model of violation is described with 10 keys and 152 factors (2016 Kang et al).

Figure 1. A Classification of Influencing Factors of Violations in Nuclear (Kang, et. al. 2015)
More complicated understandings on violations are psychological modes, status, and cognitive level of human error nature. Reason’s taxonomy shows a typical classification of human errors in a perspective of psychology. It utilizes an interpretation of internal process of memory, attention control and others. Intention especially discriminate the violations and sabotage from more typical slip, lapse, and mistakes. Safety culture instead of violations becomes prevailing as a common and descriptive term of the most of recent safety reports that included violations especially (2019 NSSC, 2020 Jung). It sometimes raises more sophisticated issue of safety culture, that might be one of the most prevailing words within event investigations nowadays around nuclear and a conclusive measure to get nuclear safety after Fukushima and Chernobyl accidents. Mainly after IAEA’s self-assessment model there have been various efforts to resolve the safety culture issue by adopting system dynamics simulation, organization/attribution model, business process modeling, competence enhancement, managerial regulatory model, and others (2020 Lee). In the other side of efforts on safety culture, more scrutinized taxonomy and schemes to capture the details of safety culture have been articulated rather than studying the violation itself. Safety culture may not separated from human errors including violations and even up to sabotages. New categorizations are proposed in terms of EOC (error of commission) (2019 Kim) and EOO (error of omission) such as mannerism (2014 Lee), and to cover the security issues together (2018 Suh & Im). The safety culture looks a main issue in human error events in spite of three plausible regressions (2016, 2018 Lee). Human error taxonomy could be extended to include this new comer of violations rather than safety culture. The causal factors within human error event investigation should be exhaustive for including all HOFs (human and organizational factors). A study example is the lessons learned from trip events extended to the organizational factors as the main results of human error investigations (2009 KAERI, 2014 Kim et. al.)

3. CULPABILITY ISSUES ON VIOLATIONS

Human error investigations meet the concerns of responsibility, since the errors can be described as a pass over the rules and criteria, and understood with a repent. It frequently reveals issues of blame to people just involved in the event. A substitution test logic to discriminate the ‘honest error’ is an example of the culpability study on violations in aviation.
It seems an articulated guide for discriminating acceptable behaviors for ‘Just’ culture in aviation. Violations can be characterized by intentions at first, however, there must be two different kinds of intentional failures. One is a failure to make an appropriate intention and the other is the problem of intention itself. The first should be separated from the faulty and bad intentions. They are focused to promote the questioning attitude and reporting more actively, however just a simple version of early considerations to provide a culpability basis to errors.

Beside the intention of consequences, other details scrutinized violations for judicial system need be investigated such as prior perception of rules and rule-breaking, etc. A more exhaustive set of keys and factors can help violation studies in more detail. (2020 Lee)

4. AN EXTENDED FRAMEWORK PROPOSED FOR VIOLATION INVESTIGATIONS

The categorization of violations may give a more details on their causes. The objectivity may be vague and quarrelsome, strongly dependent on the perspective of investigations rather than any technical one. So a further categorization of violations by incorporating the suggested factor can be beneficial but still biased to its perspective.

A new perspective of Human Error 3.0 changes the main focus of human error investigations from the factual causes to the practical countermeasures (2016, 2018, 2019 Lee). A few postulations on violations are suggested as followings

- cause is not necessarily to be a countermeasure
- influenced externally rather than internally
- external factors is to be managed
- blame is not always effective/true to violations

A study on the three eras of human error studies according to the consequences and their measures into Human Error 1.0~3.0 describes suggestions enough to include violations as a new type of human errors during human error event investigations. It might be inevitable to add three additive layers of analysis on human error events.

Table 2. Different Layers to Violations Analysis

<table>
<thead>
<tr>
<th>functional level</th>
<th>event sequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>behavioral level</td>
<td>human assignments : R&amp;R</td>
</tr>
<tr>
<td>culpability level</td>
<td>consequences, countermeasures</td>
</tr>
</tbody>
</table>

The culpability level includes two respective analyses on human errors. The one is level of responsibilities assigned prior events. It can be conducted according to the objectiveness and validity. However another different analysis is focused to the necessity to ask responsibility within the countermeasures after the human error analysis.

A new concept of Human Error 3.0 can be incorporated to assess the violations during human error investigations especially for countermeasures of more practical purpose. It has more focused to the countermeasures rather than causes of human error events, since the effective countermeasures can be different from the causal factors in practice. Violations may have culpabilities to blame the person of human error behaviors, however, be beneficial for a more practical approach to include violations within the eventual consequences of human error events.

5. DISCUSSIONS AND CONCLUSIONS

This is a preliminary study on the culpability of violations during the human error investigations. Further study in on-going in nuclear especially for regulation side. Violations also can be described as a just non-compliance of rules and criteria at first, but eventually concluded into a rule-breaking, an abuse, a criminal activity, and other culpability terms. Violation itself not means a necessity of blame to human but an effective countermeasure. A multi-layered investigation to human errors may be beneficial to cope with the following demanding issues rather than safety culture in nuclear.
organized irresponsibility
human credibility in security and insider threats
organizational responsibility to stress test
optimal R&R within and between organizations
judical and technical study on human errors

Human errors are expected to be seldom solely deliberate and malicious in a system. Moreover they are induced by the situation-and-atmosphere of overall system. The responsibility blaming and related safety culture issues to violations might be inventable and sensitive to public especially for the safety in nuclear events. The technical understanding for lessons learned should go before the blaming process. Experiences of human errors in nuclear are very rare and expensive, however, they are also invaluable to reveal the uncovered limitations of system internals and to fix them with countermeasures. Violations are informative with other human errors, too. So the proposed culpability approach to violations requires further study with more emphasis to countermeasures available and recommendable in a system.

ACKNOWLEDGMENT

This paper is supported by the Nuclear Safety Research Program grant funded by Nuclear Security and Safety Commission (NSSC) and KOFONS (No. 2003010).

REFERENCES
2. Hudson, P. et. al., Bending the Rules: Managing Violation in the Workplace, Society of Petroleum Eng. Int. Conf. on Health, Safety & Env. in Oil & Gas Exploration, 1998
4. KAERI, Lessons Learned from the Trip Cases in Korean NPPs, 2007, 2009
11. Lee, Y.H., An Introduction of Human Error 3.0 Concept to Cope with the Safety Culture Issue in Nuclear, KNS-2018 Fall, 2018
12. Lee, Y.H., How to Consider the Unexpected Situations for the Human Factors Verification and Validation, Proc. ESK-2018 Spring, 2018
16. Lee, Y.H., A Revisit to the Technical Issues and Approaches For the Investigation of Human Error Events, KNS 2019 Fall, 2019
17. Lee, Y.H., How to Treat Violation Errors during Human Error Investigations in Nuclear Events, KNS 2019 Fall, 2019
18. Lee, Y.H., A Categorization of Violations based on the Key-Factors and Plausible Countermeasures in Human Error Investigations of Nuclear Events. KNS 2020 Spring, 2020
22. Suh, Y. and Im, M. Experimental measurement of Human Errors using psycho-physiological signals, ESK 2018 Fall, 2018