Transactions of the Korean Nuclear Society 2019 Autumn Meeting
KINTEX, Korea, Oct. 23~25, 2019

How to Treat Violation Errors during Human Error Investigations in Nuclear Events

Yong-Hee Lee
I&C and Human Factors Division, Korea Atomic Energy Research Institute (KAERI)
Daedeok-daero 989-111, Daejon, Korea, 34050
✉ yhlee@kaeri.re.kr

1. Introduction

Recently human errors burst again to contribute to many industrial accidents as well as nuclear events in Korean and other countries. Violations among types of human errors especially have been focused due to both the importance of impact to the safety and the responsibility to the public. Violations have traditionally been studied as managerial and socio-psychological matters such as safety culture. However it becomes beneficial to cope with them by technical approach. This paper describes a brief review on the characteristics of violations among the types of human errors, and propose a preliminary approach to violations with a revised concept of *Human Error 3.0* and *Resilience Engineering*.

2. A Brief Review on the Human Error Investigations in Nuclear

Many countries and utilities are utilizing various versions of human error investigation process and systems, that could not far from ones coming from industrial safety such as human factors checklists, HAZOP, MORT, and others. The advanced investigation process and systems on human error events in nuclear have been adopted basically from military and aviation area. They have been developed further after many practical experiences such as TMI, Chernobyl, and Fukushima accidents.

Human error investigation shows more exhaustive in nuclear than in industrial safety. In order to find out all possible causes to verify that the analysis results and the corresponding countermeasures, it becomes persuasive enough to restore the technical and public confidence on the safety of nuclear system. HPES and HPIP could be a typical archetype for the human error investigation in nuclear. They includes more than several hundreds factors to check out in early works of investigations, and various staged steps of practical processes to finalize the investigations into a countermeasures.

The scope of investigations under the name of analysis on human errors becomes extended further and further, and the details have included exhaustive set of scrutinized steps and wide-spread factors such as organizational and cultural factors. They must be really influencing, however, go beyond technical approach. Additionally, the retrospective nature of investigations on human errors makes the burden and difficulties of right time and right things on the factual information about the human error inevitable in practice. Concealments to the real causes would be also encountered due to the nature of responsible parts. Consequently many archetypes of human error investigation systems such as HPES and HPIP has revealed their limitations on the practical and technical matters. Though many features have been developed to support and lesson the burden of the investigation of especially the causal analysis, they sometimes reduced to skip their steps and the factors in brief.

Lastly, the outcomes from the human error investigations have not gone beyond the traditional causes and the countermeasures such as “ask more alertness and attention of human”, and “enhance the supervision to human”. Further training and educations have been very typical countermeasures even for the hugh level of safety in nuclear. Safety campaign has been a typical countermeasure to the human errors, especially to the violations errors. Sometimes kinds of additional requirements beyond the supervision have been enforced in form of regulations with more scrutinized criteria and the personal penalty rather than incentive. These traditional countermeasures to the human errors may compress the human error potentials rather than uncover the hazards of human errors and conduct any proactive prevention. Violation errors have shown the worse conditions comparing to the other type of human errors

3. Characteristics of Violations and Limits to Investigations

Violation error is a little different from the other types of human errors such as slip, lapse, and mistakes. Psychology has specified the violation errors that should be intended, though the others could not be intended(1992 Reason).

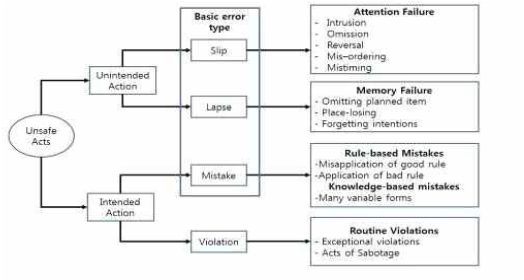


Figure 1. Types of Human Errors (by Reason)

Causal reasoning on a violation shows some internal reasons that should be changed to change the intention before they becomes in influence the concrete behavior(s). Consequently, the prevention of violation errors requires (if any possible) interventions to the internal mechanism of personal psychology.

Violations with intentional characteristics also reveal a responsibility and *blame-oriented* perspective rather than the technical and remedial perspective. It goes worse than other types of human errors to investigate the violations, though the current limits of human error investigations described in the former section.

4. A Technical Approach to Violation Errors

Hudson et al. showed that there are different types of violations, and Kang, et. al. revealed a possibility to figure out the influencing factors rather than internal psychology. Lee also suggested that technical interventions can be articulated to most of violation look feasible in practice. Several types of following violations turned out to be induced externally by detectable surrounding factors, and might be manageable by technical efforts (revised from 2018 Lee and 2015 Kang et. al.)

- Optimization violations
- Convenience violations
- Routine/Permitted violations
- Temporal/Exceptional violations
- Asked/avoidance violations
- Test violations

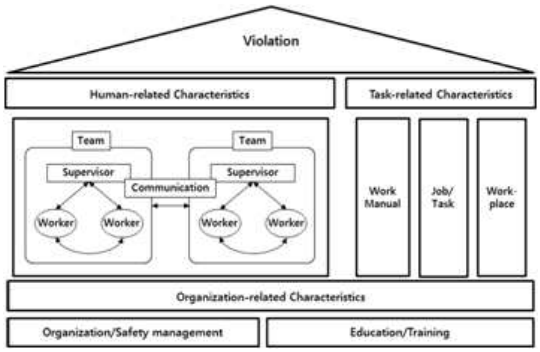


Figure 2. Violation Errors and Influencing Structures (Kang, et.al. 2015)

Figure 3. Violation Errors and Influencing Factors (Kang, et.al. 2015)

Violations can be struggled with technical interventions if the investigations upon them changes from the traditional and cultural aspects to a new concept of human error. Safety culture perspective and corresponding studies have frequently concealed the possible enhancement to the nuclear safety by intervention to violations.

Human error investigations sometimes were stopped when they encountered to the violations and can be explained by many cultural factors. However it is very vague whether they are causes to the violations or reasons of happenings. Safety culture issues sometimes make the practitioners avoid any further efforts to find the practical mechanisms of human error events such as organized irresponsibility with causal and situational factors, and reach to the more practical countermeasures finally(2018 Lee).

Since the causal factors themselves could not be more prioritized than the counter-measures, the investigation on violation errors as well as the on the other types of human errors should be focused to the external influencing factors, and some of them could be selected into the countermeasures through cost-benefit analysis and MADM(multi-attribute decision making).

5. Issues and Taska for A Revised Approach to Violations with New Concept and Paradigms on Human Errors

5.1 New Concept of Human Errors 3.0 and New Paradigm of Safety for the Investigation of Violation Errors

There are further new concepts and new paradigms proposed to the prevailing issues of emerging new technologies and the demanding safety concerns from many human-made accidents. Normal Accident paradigm and High-Reliability Organization concept nowadays has become prevailing after TMI accident and succeeding industrial accidents. The Big-One and Risk-Society paradigm elucidated more efforts

required to cope with risky nature of modern technological societies.

Recently Human Error 3.0 concept and Resilience Engineering were proposed to be more-equipped with effective management of risk such as organizational and cultural concerns. However a more concrete details are now required to the every task of human-related safety rather than human-induced risks and disasters. The concept of Human Error 3.0 can be applied especially to cope with the new type of violation errors such as avoidance, negligence, flee and freeze, and over-fight. It can provide a robust foundation to establish a more effective approach that the burden of investigation becomes resonable and the countermeasure could be more practical in investigation processes.

Human Error 3.0 can be differentiated from the other Human error 1.0 & 2.0, since it comes more from unknowns rather than known limitations of human and the surroundings to human in a system. The concept suggests an open attitude to the scope of analysis to extend the causality to plausibility of influencing factors in order to find a more practically effective countermeasures to the human errors.

The concept of resilience also provides more practical approach to human error investigations since the final goal of safety is not limited to the rigid protection to the external hazards and the tolerant integration of the internal safety mechanisms. There can be found that many practical countermeasures to cope with violations by incorporating wider strategies of human errors such as mitigation, compensation, and restore from the errors rather than direct redundancy, tolerance, by-pass, and other intrinsic safety concepts.

5.2 Safety Culture, Security and Violation Errors

Current regulatory requirements on human error events in nuclear look rather not-practical since the main theme of investigations has been focused to the causes rather than the countermeasures. The technical issues contributed to the human errors sometimes become transformed into the safety cultural and political issues since they revealed very sensitive after Fukushima accident and Kori #1 concealment event. An enforced regulatory position was pronounced to consider safety culture aspects about the severity of events in Korea. A starting point of human error investigations is that human error is not a (causal) factor of events but a event itself with a different perspective. Safety culture issues such as *Organized Irresponsibility* can be rather concealed again with the details of human error events especially violation errors.

Violation errors for the security as well as the safety will become more difficult to be understood properly and managed practically due to the characteristics and nature of human errors. By applying *Human Error 3.0* and other emerging safety concepts and paradigms they should be understood technically rather than politically, and treated with the more concrete information than the vague cultural matters. They could be illegal and go out from the pre-determined bound for security. Recent studies on insider threat to the security showed that there could be a objective measure and external countermeasure to violations that may come not random-and-unavoidably but technically. (Suh & Im 2018, Lee 2018)

Another different kinds of violation errors under the name of *sabotages* also can be treated with *Human Error3.0,* since sabotage is basically coming from outside and can be monitored and intervened technically.

5.3 Human Factors Safety Verification against the Violation Errors

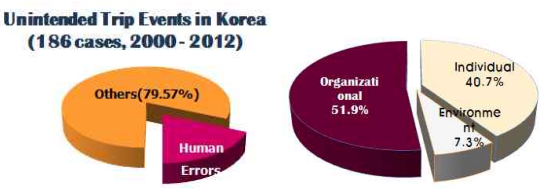
Current human factors verification may not enough to provide the confidences to the human-error-free system. It is inevitable to take a retrospective approach from the experienced events about the violation error if a different approach and investigation systems will not be available to the human error events in nuclear.

A preliminary approach to human factors safety verification was proposed to enhance the current limitations of HFE V&V by suggesting a template to guide to check proactively any potential of human errors (three different kinds of errors might be *3Fs : Flee, Fight and Freeze*) in unexpected situations in nuclear. (2018 Lee)

However violation in an unexpected situation should be more precisely investigated since the definition of violations can be changed from the normal behaviors. And the 3 F's paradigm is just a current-best approach to consider the unexpected behaviors, it should be revised and articulated into a more detailed and practical guide with evidences of violations from experiences.

6. Conclusions and Discussions for Further Research

Human errors including violation errors become related more to organizational factors, and require a different approach for the lessons learned rather than the causes (KAERI 2009).



Violations should be treated more carefully especially in nuclear since their influencing impact to the safety itself and the sensitivity to the public become larger and larger. I discussed the comparative natures of violation errors, the limitations of current human error investigations especially in nuclear, and proposed a preliminary concept and approach by virtue of *Human Error 3.0* and other new safety paradigm such as *Normal Accident*, *Resilience Engineering*, Organized Irresponsibility, and others.

The existing human error investigation process and systems should be enhanced to overcome the traditional concepts and paradigms on human error and safety, from especially the cause-oriented analysis to countermeasure-focused investigations. Proactive changes including regulatory area can be suggested with a further consensus on these preliminary reviews and proposed approach to the violations as well as the types of human errors in nuclear.

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