Transactions of the Korean Nuclear Society Autumn Meeting
Gyeongju, Korea, October 29-30, 2015

Unsafe Acts from Human Performance Analysis with Simulator Training Data

Sun Yeong Choi*, Yochan Kim, Jinkyun Park, Seunghwan Kim, and Wondea Jung

Korea Atomic Energy Research Institute, Integrated Safety Assessment Div., Daedeok-daero 989-111, Yuseong-Gu, Daejeon, Republic of Korea, 305-353
sychoi@kaeri.re.kr

1. Introduction

Many researchers have emphasized the effect of human performance related problems on the safety of complicated process control systems, such as NPPs (Nuclear Power Plants), aviation industries, offshore industries and transportation systems including railway systems [1-3]. From those researches, it is well known that the contribution of human performance related problems (or human error) to the safety of socio-technical systems is critical. Moreover, it is reported that about 75% of all accidents and/or incidents that have occurred in the complicated process control systems are attributable to human error [4]. Therefore lots of efforts to perform an HRA (Human Reliability Analysis) based on various approaches made to enhance their safety. HRA data is an important prerequisite for improving HRA quality [5].

For this reason, KAERI (Korea Atomic Energy Research Institute) developed a standardized guideline is to specify how to gather HRA data from simulator training records and crated IGT (Information Gathering Template) specifying what kinds of measures should be observed during the simulations [6]. Based on the data collection framework, we have performed data collection to analyze inappropriate human behavior (or UA; Unsafe Act) with simulator training data about various scenario needed AOP (Abnormal Operation Procedure) or EOP (Emergency Operation Procedure) operations for HEP (Human Error Probability) calculation. In this research, UA is defined as an inappropriate human behavior that has a potential for leading the safety of NPPs to a negative direction.

The purpose of this paper is to describe a process of UA analysis through a case study under a simulated emergency and the analysis results.

2. Methods and Results

2.1 Process for UA Identification

As mentioned above, an UA is an inappropriate human behavior that has a potential for leading the safety of NPPs to a negative direction. Thus the consequence by UA includes an inappropriate execution, inappropriate transfer to other procedure or step, and extraneous act during AOP/EOP operation. From this concern, all kinds of deviations from following operating procedures (e.g., AOPs and EOPs) could be regarded as UA candidates, because these operating procedures contain many tasks to be done by operating personnel, which are very important to reduce the consequence of accident sequences. Figure 1 shows how the behaviors of operating personnel can be scrutinized on the basis of plant situations and tasks. The figure is cited from the guideline we issued. UA candidates can be easily identified by examining whether or not the utterance and manipulation of operating personnel are coincident with the paths from (1) to (5) since the paths indicate the criteria of operator behaviors.

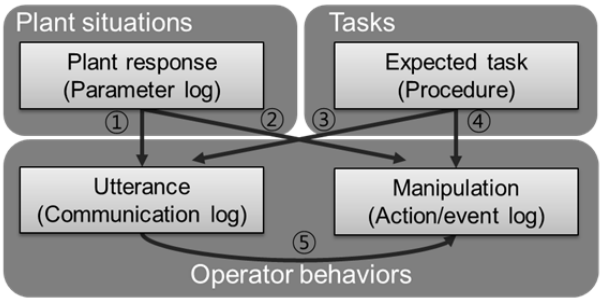

Figure 1. Examination of UA candidates

- Path (1): when information reported by operating personnel is not appropriate to the associated plant parameter
- Path (2): when a component manipulation by operating personnel is not appropriate to the environment including operating condition for the component manipulation
- Path (3): when instruction by operating personnel is not appropriate to the related task of a procedure
- Path (4): when a component manipulation by operating personnel is not appropriate to related task of a procedure
- Path (5): when a component manipulation by operating personnel is not appropriate to the related instruction from others

After UA candidates are selected, UAs leading to the consequences mentioned above are identified among the UA candidates.

2.2 Unsafe Acts from Case Study on ISLOCA

The scenario for the case study is an ISLOCA (Interfacing System Loss of Coolant Accident) which requires a cognitive operator performance since the related symptom often occurs in more than two kinds of systems and its occurrence frequency is relatively low. We collected data on simulated emergency operation trainings for the scenario at a Westinghouse 3-loop PWR. The participating operators use EOPs developed by the Westinghouse Owners Group [7]. EOPs used for the simulated scenario are E-0 for reactor trip or safety injection, E-1 for loss of reactor or secondary coolant, and ECA-1.2 for loss of reactor coolant outside containment vessel. When a simulation is started, crew performs E-0 operation since an ISLOCA will cause a reactor trip. After entering E-0, operators would transfer to E-1 and ECA-1.2 sequentially.

Table 1 shows examples of UA analyzed from simulator training data under ISLOCA. We classified UAs into three kinds of stage that reflects crew interaction (i.e., instruction-response) during EOP operation.

Table 1. Examples of UA under ISLOCA Scenario

Category	UA Description	Consequence
Instruction Stage by SS (Shift Supervisor)	Ahead of E-1, step 1.0, there is a note that an 'emergency alert' should be notified according to the emergency plan. However, an SS missed to order the instruction and consequently a BO (Board Operator) did not notify it, while requirements for the emergency alert were satisfied.	Inappropriate execution
	An SS missed performing step 11.2 of E-1, which is to check radiation inside auxiliary building. Generally, crew should transfer to ECA-1.2 in this step since radiation in an auxiliary building exceeds the set point. But the crew failed to transfer to ECA-1.2.	Inappropriate transfer
	During E-1 operation, an SS did not instruct step 8.3 for SI (Safety Injection) signal reset and then instructed step 8.4 for RHR (Residual Heat Removal pump stop. Therefore 'trouble' alarm was raised since a BO stopped the RHR pump without SI signal reset.	Inappropriate execution
Reporting Stage by BO (Board Operator)	For step 11.2 of E-1, a BO failed to check a leakage in a RNO (Response Not Obtained) part even though an SS transferred to RNO part and ordered the instruction in the RNO part appropriately.	Inappropriate transfer
	For step 9.0 of E-1, a BO reported that the pressure of SG (Steam Generator) is stable according to an SS's instruction to check pressure in all SG, it, however, was decreasing obviously by a parameter log. By the decreasing SG pressure the crew should transfer to RNO part and follow the direction in the RNO part. But they could not transfer to the RNO part.	Inappropriate transfer
Manipulation Stage by BO	A BO stopped RHR pumps that SS did not them to stop. Besides, operation condition for RHR pump stop was not satisfied.	Extraneous act

3. Conclusions

In this paper, we described the process for UA identification and demonstrated examples of UA accompanied by consequence by a case study on ISLOCA scenario. We classified UAs into three categories considering crew interaction during EOP operation. Further works, UA classification by considering crew interaction during AOP/EOP operation would be developed in detail.

Acknowledgement

This work was supported by Nuclear Research & Development Program of the National Research Foundation of Korea (NRF) grant funded by the Korean government, Ministry of Science, Ict & future Planning (MSIP). (Grant Code: 2012M2A8A4025991)

REFERENCES

[1] Choi, S. Y., and Park, J., Operator behaviors observed in following emergency operating procedure under a simulated emergency. Nucl. Eng. Tech., 44(4), 379-386, 2012.

[2] Deacona, T., Amyottea, P.R., and Khanb, F.I., Human error risk analysis in offshore emergencies. Saf. Sci., 48(6), 803–818, 2010.

[3] Celika, M., Cebib, S., Analytical HFACS for investigating human errors in shipping accidents. Accid. Anal. Prev. 41, 66–75, 2009.

[4] Stanton, N.A., Salmon, P., Harris, D., Marshall, A., Demagalski, J., Young, M.S., Waldmann, T., and Dekker, S., Predicting pilot error: Testing a new methodology and a multi-methods and analysts approach. Appl. Ergon. 40, 464–471, 2009.

[5] Chang, J., and Lois, E. Overview of NRC's HRA data program and current activities, PSAM12, 2012.

[6] Park, J., W. Jung, S. Kim, S.Y. Choi, Y. Kim, and V. N. Dang, A guideline to collect HRA data in the simulator of nuclear power plants, KAERI/TR-5206/2013, 2013.
[7] Westinghouse Owners Group, Emergency response guidelines background (high pressure version), 1983.