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Performance Shape Factor Survey For Human Reliability Analysis Of TRIGA Research Reactor

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The development of Human Reliability Analysis (HRA) framework of the TRIGA research reactor in Thailand was initiated by the collaboration between Korea Atomic Energy Research Institute (KAERI) and Thailand Institute of Nuclear Technology (TINT) in 2023 (Vechgama et al., 2023). Overall process of the HRA framework for the TRIGA research reactor is shown in Figure 1. In the HRA framework implementation of the TRIGA research reactor, HRA practitioners proceed to extract the information to conduct from the training sessions of Emergency Operating Procedures (EOPs) through Step 1 to Step 4. Then Step 5 will be final estimation for providing risk quantitative information of Human Error Probability (HEP) for safety critical tasks.

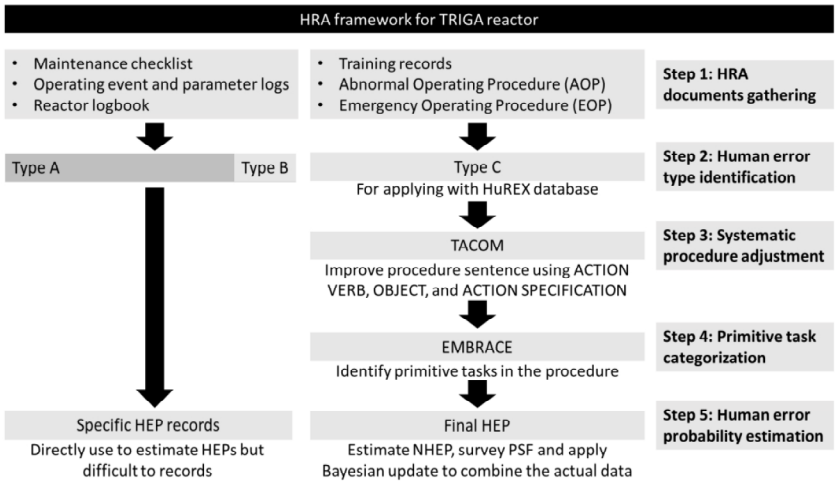

Fig. 1 Overall process of the HRA framework for the TRIGA research reactor.

In conducting the fifth step of Fig. 1, firstly, the HRA framework of the TRIGA research reactor suggested to apply the EMpirical data-Based crew Reliability Assessment and Cognitive Error analysis (EMBRACE) method in terms of identifying cognitive activities, primitive tasks, and error modes that are needed for estimating

nominal HEPs of the safety critical tasks in the EOPs. EMBRACE method was developed by KAERI to investigate the impact of a digital MCR environment on the likelihood of human errors with the HRA empirical database namely Human Reliability data EXtraction (HuREX) (Kim et al., 2019). Secondly, to finalize HEPs of safety critical tasks in EOPs, the multipliers of Performance Shape Factors (PSFs) should be determined in order to combine the realistic operating environment of the TRIGA research reactor.

Hence, the objective of this study is to survey PSFs for the HRA framework of the TRIGA research reactor based on the EMBRACE method. PSF survey was developed to reflect the environment of abnormal situations due to error of omission (EOO) and error of commission (EOC) in related cognitive activities during the operation. Ten PSFs consisting of *1) Complexity of the required task, 2) Subjective stress, 3) Complexity of the human-machine interface, 4) Procedure quality, 5) Support function of the computer-based procedure, 6) Independent reviewer, 7) Crew dynamics, 8) Communication level, 9) Training level, and 10) Career-experience level*, would be scored by ten experts in Thailand through Thai Research Reactor-1/Modification 1 (TRR-1/M1) case study.

During the PSFs' survey, the experts were gathered and asked to quantitatively rate their opinions about the effect of the abovementioned PSFs on the occurrence of human errors. For example, the EOO mode question would be given such that "Operators did not check and report if the water level is lower than 8 meters using the water level sensor". Meanwhile that of the EOC mode would be "Operators checked and reported the wrong reading on the water level during the progression of the LOCA situation". The survey covers four cognitive activities including information gathering and reporting (IG), situation interpreting (SI), response planning and instruction (RP), and execution (EX) of both EOC and EOO modes. Table 2 shows the primary results of PSFs' survey results with respect to the IG cognitive activity of TRR-1/M1 in EOO mode. The results reflected various PSF scores of ten experts originating from individual experience and domain knowledge. To improve the proper PSF score for the HRA framework, expert elicitation analysis suggested by Aspinall (2008) will be applied as the next step of the study. More detailed information including the survey results of this study will be presented in the conference.

Table 2 PSFs' survey results in Question 1 of the IG cognitive activity of TRR-1/M1 in EOO mode.

	Middle PSF score of information gathering and reporting (IG) in EOC mode									
	Expert1	**Expert2**	**Expert3**	**Expert4**	**Expert5**	**Expert6**	**Expert7**	**Expert8**	**Expert9**	**Expert 10**
PSF 1	1	1	3	2	2	3	1.5	2	3	5
PSF 2	2	2	2	3	4	5	3	2	3	3
PSF 3	2	3	3	5	3	3	2	3	2	5
PSF 4	1	4	4	3	3	5	3	5	2	5
PSF 5	1	4	4	3	3	2	1.5	5	3	3
PSF 6	2	2	4	5	3	5	3	10	5	5
PSF 7	2	4	3	5	2	2	2	1	5	3
PSF 8	2	2	5	2	2	2	1.5	10	5	3
PSF 9	3	4	2	5	3	3	2	3	3	5
PSF 10	3	2	2	2	4	3	3	2	2	5

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