Human Reliability Analysis Data Workshop Agenda

3WFN-3A28, U.S. Nuclear Regulatory Commission Head Quarters
Rockville, Maryland
March 14 & 15, 2019
Contact: Y. James Chang; James.Chang@nrc.gov; (O) +1 301-415-2378

March 14, 2018	**Topic/Title**	**Presenter/Lead Person**
08:30 – 08:40	Welcome & logistics	Mr. Mark Thaggard/ Dr. Y. James Chang
08:40 – 09:25 (T1)	Generalization and Integration of Human Error Data to Inform HEP Estimation (1)	Dr. Jing Xing (NRC)
09:25 – 10:10 (T2)	The application of HRA data in HRA quantification methodology "IDHEAS-ECA" (2)	Dr. Song-Hua Shen (NRC)
10:10 – 10:30	Break	
10:30 – 11:15 (T3)	HuREX data generated from APR1400 simulator and its application plan (3)	Dr. Yochan Kim (KAERI)
11:15 – 12:00 (T4)	Microworld Studies to Support Human Reliability Data Collection (4)	Mr. Jooyoung Park (Visiting Scientist in INL)
12:00 – 13:30	Lunch	
13:30 – 14:15 (T5)	Types of data and insights for HRA quantification (5)	Dr. Katrina Groth (UMD)
14:15 – 14:25	Break	
14:25 – 15:10 (T6)	Development of a Quantitative Bayesian Network Mapping Objective Factors to Subjective Performance Shaping Factor Evaluations: An Example using Student Operators in a Digital Nuclear Power Plant Simulator.(6)	Dr. Yunfei Zhao (OSU)
15:10 – 15:55 (T7)	Status of SAMG and FLEX/MACST HRA Methods in KAERI (7)	Dr. Jaewhan Kim (KAERI)
March 15, 2018		
08:30 – 09:00 (F1)	Human Reliability Data for Central Control of Modern Power Stations, a review of HRA data needs and HRA data collections. Presentation of a survey done by CRA Risk Analysis and IFE for EDF Energy in the UK.	Mr. Andrea Bye (IFE)
09:00 – 09:30 (F2)	Overview of the HRA Activities Presented in PSAM 14 Workshop	Mr. Jeffrey Julius (Jensen Hughes)
09:30 – 09:50	Break	
09:50 – 10:20 (F3)	Overview of EPRI's HRA Activities	Ms. Mary Presley (EPRI)
10:20 – 10:50 (F4)	SACADA Status and the Data Available to HRA Community (8)	Dr. Y. James Chang (NRC)
10:50 – 11:00	Break	
11:00 – 12:00 (F5)	Roundtable Discussion – Summary of current and planned HRA activities	All attendees

12:00	Adjourn	

Presentation Abstract:

(1) Generalization and Integration of Human Error Data to Inform HEP Estimation

- Dr. Jing Xing

The Integrated Human Event Analysis System – General Methodology (IDHEAS-G), a human reliability analysis method developed by the US Nuclear Regulatory Commission, provides a hierarchical structure to analyze and assess the reliability of human actions. The method is based on cognitive science and is capable of incorporating human performance data to support the estimation of human error probabilities. IDHEAS-G models human performance in five macrocognitive functions: *Detection, Understanding, Decision-making, Action execution, and Teamwork*. IDHEAS-G defines a set of cognitive failure modes (CFMs) for each function. IDHEAS-G also comes with a performance influencing factor structure with a comprehensive set of PIFs and their attributes. The CFMs and PIF structure together provide an intrinsic interface to generalize various sources of human error data for human error probability estimation. We use IDHEAS-G to generalize numeric data of human errors in the literature and operational databases into three tables: a Human Error Probability Table maps human error data to corresponding CFMs, a PIF Impact Table maps human error data to the weight of a PIF on human error probabilities, and a PIF Interaction Table documents human error data to elucidate the combined effect of multiple PIFs on human error probabilities. The data, once sufficiently populated, can provide a basis for estimating human error probabilities. This presentation will demonstrate data generalization to the three IDHEAS-G Human Error Tables and foster discussion among the attendees on how the generalized data should be integrated to inform human error probability estimation.

(2) The application of HRA data in HRA quantification methodology "IDHEAS-ECA

- Dr. Song-Hua Shen

IDHEAS-ECA is a new developed methodology to quantify Human Error Probability (HEP). IDHEAS-ECA is developed based on HRA Methodologies: SPAR-H, IDHEAS-G, and Phoenix. This presentation will provide basic concepts of IDHEAS-ECA and the applications of the HRA data in IDHEAS-ECA improvement.

(3) HuREX data generated from APR1400 simulator and its application plan

- Dr. Yochan Kim

Human reliability issues related to digital interfaces have been dealt with recently because of the commercial operation of advanced power plants equipped with digital control rooms and the modernization of the control room. To obtain empirical data on the human reliability analysis, KAERI is extracting the reliability data from an APR1400 simulator. This presentation briefly introduces the data collected so far through the HuREX (Human REliability data EXtraction) system and shows how we plan to use it. Specifically, the various kinds of operator performance times were estimated, and the average HEPs for the HuREX tasks were estimated. Based on the extracted estimates, a new HRA method is being developed to quantify the failure probability of timely

performance, the failure probability of task completion, and the failure probability by unguided control.

(4) Microworld Studies to Support Human Reliability Data Collection

- Mr. Jooyoung Park

The Rancor Microworld provides a simplified nuclear process comprised of a nuclear reactor core heat source and turbine generator for gamified simulation. The microworld can insert faults on various components to simulate common training scenarios, such as steam generator tube rupture, failed sensor and setpoint controller, reactor trip, and turbine trip events. It is also used to evaluate operator performance with new technologies and interfaces. To date, Rancor has been used in three studies using university students, steam plant operators, and licensed reactor operators to examine performance, situation awareness and attention, and determine the extent to which human performance findings from students are generalizable to reflect actual reactor operators. Current research is now using Rancor to investigate human error during operations with digital technologies including computer based procedures, automation, and multi-unit operations. Rancor provides a unique capability to extend research beyond full-scope simulators. Full-scope simulator studies are the gold standard; however, they are expensive to perform and often fail to yield conclusive results due to the limited sample size of operators available and the inherent complexity of the control room that can confound definitive findings. Furthermore, universities and smaller laboratories often cannot afford to perform these studies, and even large research entities do not necessarily have the resources needed to address human factors and human reliability analysis (HRA) issues associated with new digital control systems. The Rancor Microworld was developed to provide a platform for smaller research teams to conduct human factors and HRA research specifically for the nuclear domain. As such, it is intended as a complement to larger full-scope simulator studies. This talk summarizes the applicability of findings from microworld simulator studies to inform HRA.

(5) Types of data and insights for HRA quantification

- Dr. Katrina Groth

The talk centers around some of my (Katrina Groth) experiences from using HRA data, rather than discussing a specific data source. It will include a brief discussion of some data sources I've worked with (SACADA, HERA, and sources we gathered to help the IDHEAS expert elicitation) as well as the modeling pieces needed to use the data (e.g., PSFs, task breakdowns, causal models and factorization). Hopefully this aligns with what you're envisioning for this workshop.

(6) Development of a Quantitative Bayesian Network Mapping Objective Factors to Subjective Performance Shaping Factor Evaluations: An Example using Student Operators in a Digital Nuclear Power Plant Simulator

- Dr. Yunfei Zhao

Traditional human reliability analysis methods consist of two main steps: assigning values for performance shaping factors (PSFs), and assessing human error probability (HEP) based on PSF values. Both steps rely on expert judgment. Considerable advances have been made in reducing reliance on expert judgment for HEP assessment by incorporating human performance data from various sources (e.g., simulator experiments); however, little has been done to reduce reliance on expert judgment for

PSF assignment. This paper introduces a data-driven approach for assessing PSFs in Nuclear Power Plants (NPPs) based on contextual information. The research illustrates how to develop a Bayesian PSF network using data collected from student operators in a NPP simulator. The approach starts with a baseline PSF model that calculates PSF values from context information during an accident scenario. Then, a Bayesian model is developed to link the baseline model to the Subjective PSFs. Two additional factors are included: simulator bias and context information. Results and analysis include variation between the results of the proposed model and the training dataset, and the significance of each element in the model. The proposed approach reduces the reliance of PSF assignment on expert judgment and is particularly suitable for dynamic human reliability analysis.

(7) Status of SAMG and FLEX/MACST HRA Methods in KAERI

- Dr. Jaewhan Kim

The presentation summarizes KAERI's current status on development of HRA methods for Level 2 PSA (SAMG) and FLEX/MACST actions. In SAMG HRA, it focuses on qualitative analysis framework as well as data and information requirements, and in FLEX/MACST HRA, it presents a draft guideline for assessing mitigation strategies and actions using portable equipment, which includes both considerations of internal events and external events (specifically a seismic event). Some case studies using the suggested framework and methods will also be presented for both a severe accident scenario and an extended loss of AC power event.

(8) SACADA Status and the Data Available to Public

- Dr. Y. James Chang

This presentation provides a brief update of SACADA operation status, and a more detailed discussion of the empirical operator performance data in simulator exercises will be available to public. The data includes collected from nuclear power plants and research laboratory. In the first phase, the relation between context (characterized by context factors according to SACADA taxonomy) and performance statistics will be available. The data are grouped based on cognitive functions, i.e., detecting alarms, reading parameters, diagnosis, making decision, and action. In the second phase, the operator performance deficiencies details will be provided based on the context. In the third phase, the descriptions of the operator actions with their corresponding cognitive types will be provided. The first phase of data will support the estimates of context-specific human error probabilities. The second phase of data support the analysis of the relation between context and error modes. The third phase of data provide clarification about the procedure instructions and their corresponding cognitive types as characterized by plant instructors and experiments conductors. The NRC plans to update the data periodically.