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# Comparison of HuRAM$^+$ and HERA for Development of Data Worksheet for Simulator-based HRA Databank

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## 1. Introduction

The Korea Atomic Energy Research Institute (KAERI) launched a project in 2012 to develop a simulator-based human reliability analysis (HRA) data handbook that can support the generic process of HRA by using the full-scope simulator of Korean nuclear power plants in 2012. The scope of the project covers post initiating HFEs included in internal events HRA. We defined the minimum requirements of information for the HRA process from restructuring the contents of existing documents such as the requirements, standards, and guidelines [1]. We also compared the existing HRA methods and HRA database to select essential data fields [2]. We performed a preliminary study to see the possibility to induce the operator's emergency operating procedure (EOP) noncompliance behaviors under a simulated emergency [3].

The purpose of this paper is to compare the HuRAM$^+$ and HERA to obtain an insight into the construction of a data worksheet for a qualitative HRA. In this paper, we performed a case study for applying simulator training data to HuRAM$^+$ and HERA. With this insight, as well as the results of the researches mentioned above, we have a plan to develop a systematic and qualitative HRA and a data worksheet for the work.

## 2. Methods and Results

### *2.1 HuRAM$^+$ and HERA*

HuRAM$^+$ was developed by KINS to support an examiner during an event investigation to identify inappropriate human actions and their relevant root causes [4]. HERA was developed for the NRC as a repository of retrospective qualitative analysis of actual or simulated incidents. The objective of HERA is to make available empirical and experimental human performance data, from commercial nuclear power plants (NPPs) and other related technologies, in a content and format suitable to HRA practitioners [5].

Figure 1 shows a structure for the HRA process of HuRAM$^+$ and HERA and relations among data fields. HuRAM$^+$ consists of seven analysis steps. A (event description) and B (event sequence / HSE) are for a brief summary for a human related event while C (HSE information), D (HSE task/context information), E (error mode analysis), and F (PSF analysis) are for each human subevent (HSE) involved in the event. Similarly, Worksheet A is for an event that consists of more than a subevent and Worksheet B is for the subevents with HERA. HERA defines nine kinds of subevents, which are categorized by an event-type group (i.e., human, plant, and external) and related information (i.e., positive outcome, negative outcome, and contextual information).

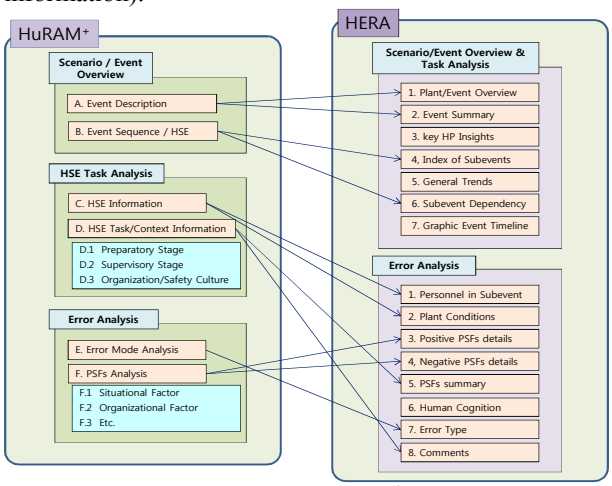


Figure 1. Structure of HuRAM$^+$ and HERA

### *2.2 Case Study*

We analyzed simulator training data for a main steam line break (MSLB) and a nearly coincident steam generator tube rupture (SGTR) with HuRAM$^+$ and HERA. We collected data on nine simulated emergency operation training cases for the scenario at a Westinghouse 3-loop PWR. Figure 2 and 3 show examples of a case study with HuRAM$^+$ and HERA respectively.

For HuRAM$^+$, since the structure of the worksheet is simpler than HERA's, it is somewhat convenient to input data into the HuRAM$^+$ worksheet, especially the error mode part. Organization and safety culture factors are strengthened, however it is not easy to input data for the data fields.

Since HERA was developed to provide an HEP for probabilistic safety assessment (PSA), it includes data fields for an HEP estimation such as recovery action and dependency those HuRAM$^+$ does not consider. However, it impose burden on time and cost to input

data into HERA data worksheet. HuRAM$^{+}$ and HERA commonly have too many performance shaping factors (PSFs) to analyze them.

## 3. Conclusions

In this paper, we compared HuRAM$^{+}$ and HERA to obtain an insight into the construction of a data worksheet for a qualitative HRA and performed a case study. HERA requires a burden to analyze and input an event data due to too many data fields even though it is well designed to estimate HEPs. It is somewhat more convenient to input data into the HuRAM$^{+}$; however, it is difficult to analyze the organization and safety culture factors.

We are now trying to develop the framework of a data worksheet for a qualitative HRA based on simulator training data. The purpose of our data worksheet is to provide key information for HEP estimation and to enhance the understanding of an operators' behavior under an off-normal plant status. We aim less encumbered means of obtaining the needed data for HRA by changing the existing data worksheet framework of HuRAM$^{+}$ and HERA and by reducing data fields that require reading the between the lines.

## ACKNOWLEGEMENT

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Foundation of Korea (NRF) grant, funded by the Korean government, Ministry of Science, Ict & future Planning (MSIP).

## REFERENCES

[1] Park J. & Jung W., "High level requirements of necessary information for supporting human reliability analysis (HRA)," KAERI/TR-4740/2012, 2012.
[2] Choi S.Y., Kim Y., Kim S.H., and Jung W., "Requisite definition for simulator data supporting human reliability analysis and development of worksheet," KAERI/TR-4911/2013, 2013
[3] Choi S.Y. and Park J., "Operator behaviours with emergency operating procedure under a simulated emergency," Journal of Nuclear Engineering and Technology, Vol. 44, No. 4, 2012.
[4] Jung W., Kim J., Park J., and Kim S.H., "Development of a hierarchical framework for analyzing human related events, including organizational factors and safety culture," KINS/HR-952, 2009.
[5] Hallbert B., Boring R., Getman D., Dudenhoeffer D., Whaley A., Marble J, and Joe J., "Human Event Repository and Analysis (HERA) System, Overview," NUREG/CR-6903, Vol. 1, US NRC, 2006.

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|---|---|---|---|
| 사건보고서번호 | PTE8-20100825-T1 | 사건일시 | 2010. 8. 25 |
| 사건제목 | MSLB+SGTR | | |
| 발생호기 | 영광 1 발 시뮬레이터 실습 | 발전소타입 | Westinghouse |
| 운전모드 | 원자로 트립 | 원자로출력 | 0 |
| 비고 | | | |

A. 사건개요

| | | | |
|---|---|---|---|
| HSE ID | HSE-3 | HSE 발생일시 | 08:46 |
| HSE 설명 | 보드운전원이 SRO 의 지시사항을 수행하지 않고 누락하였음. | | |
| HSE 발생 상황 정보 | SRO 가 E-2 수행 중 Flodout page 에 의해 방사선 백색비상발령을 지시하였는데 이를 수행하지 않았음 | | |

C. HSE 기본 정보

| | | | |
|---|---|---|---|
| 분석근거자료 | 동영상 자료 분석 (PTE #8) | 분석자/분석일 | 최선영/2011. 5. 31 |
| 작업자/경력 | ■ 운전원, □ 기술/정비/시험원, □ 외부업체 작업자, □ 관리자, 해당 보직경력 ( )년 | | |
| 작업장소 | ■ MCR, □ 보조건물, □ 터빈건물, □ 격납건물, □ 기타( ) | | |
| 직무유형 | □ 설계/제작/설치, 시험/점검(□ 정기시험, □ 주기시험, □ 교정), 정비(□ 고장정비, □ 예방정비), 운전(□ 정상, □ 비정상, ■ 비상) | | |
| 직무분야 | ■ 운전, □ 기계, □ 전기, □ 계측, □ 기타 | | |
| 절차서/지시서 | E-2 | 계통/기기 | □ 1 차계통, □ 2 차계통 |

| | |
|---|---|
| 오류유형(I) | ■ EOO(누락오류), □ EOC(부적절한 수행오류) |
| 오류유형(II) | □ Mistake(진단/의사결정오류), ■ Slip/Lapse(수행오류), □ Violation(규정위반) |
| 오류유형(III) | □ Latent Error(잠재오류), ■ Active Error(즉발오류) |
| 오류발생시점 | □ 전출력 운전, □ 출력/감발 운전, □ 계획예방정비 |

E. 오류유형분석

| 일시 (mm/ss) | 사건경위 | HSE | 비고 |
|---|---|---|---|
| 00:31 | MSLB 발생 (SG B, inside containment) | | |
| 00:52 | SGTR (SG B) | | B. 사건경위 및 HSE |
| 01:53 | 원자로 트립 | | |
| 02:01 | EOP E-0 수행 시작 | | |
| 02:01 – 04:01 | E-0, 1.0 ~ 13.0 수행 | | |
| 04:01 – 04:16 | E-0, 14.0 생략 (확인지시생략) | | 13.1 에서 CV 압력이 1.5 를 쳤다는 것을 알아서 (이미 살수가 작동중이다란 것을 알고 있음) |
| 04:16 – 04:53 | E-0, 15.0 ~ 18.0 수행 | | |
| 05:07 – 05:28 | E-0, 19.0인 RCS 온도 점검 항목에서 TO가 온도와 압력을 같이 보고하면서 RCS 압력이 단계 21.2의 RCP 정지조건이 만족된다고 보고하여 SRO는 19.0 수행단계에서 21.2 (RCP 정지)를 지시하고 이에따라 RCP 정지 작업을 수행하였음. 그 후 20.0으로 다시 돌아오지 않고 전체 생략하면서 기기작동 (20.4, PZR PORV 차단밸브 open)을 누락하였음. (작동지시 생략, 기기작동 생략) | HSE-1 * | 최소 한 개는 열어야 하는데 이를 따르지 않았음 (SRO가 지시를 하지 않았음) |

Figure 2. Case Study with HuRAM$^{+}$

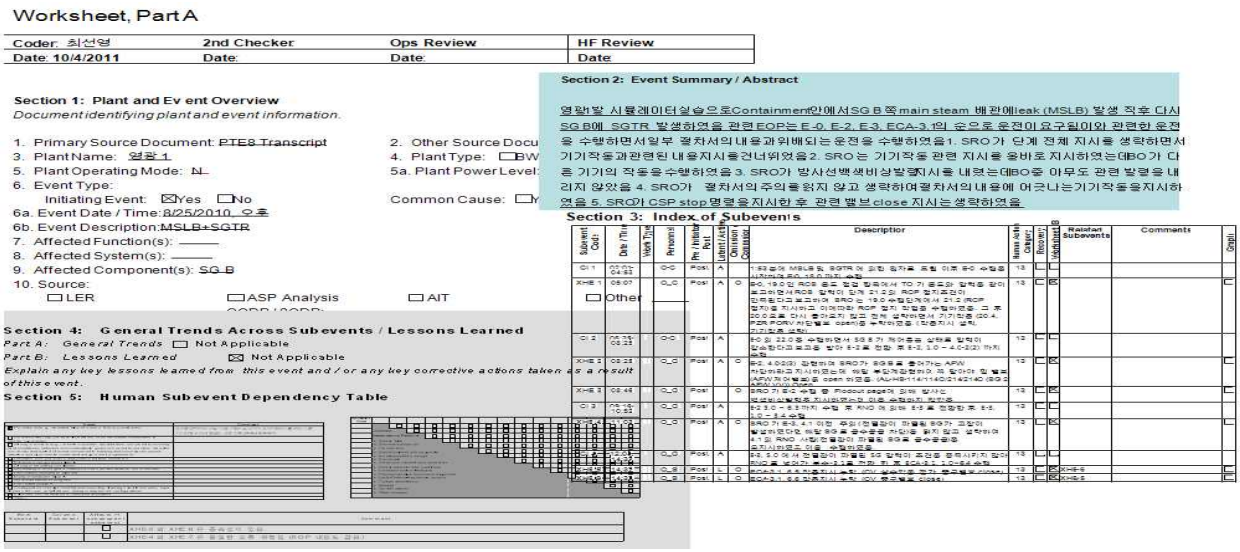


Figure 3. Case Study with HERA