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The design and implementation of a HRA calculator of nuclear power plants

Seung Hwan Kim, Dae Il Kang, Wondea Jung
Integrated Safety Assessment Division, Korea Atomic Energy Research Institute
P.O.Box 105 Yusong, Daejeon, KOREA

1. Introduction

According as the demand of risk-informed regulation and application increase, the quality of a probabilistic safety assessment (PSA) has become more important. As part of enhancing the PSA quality, a study started to standardize the process and the rules of human reliability analysis (HRA) which was known as a major contributor to the uncertainty of PSA. Performing HRA requires a lot of data to keep the quality of results. KAERI is developing the HRA calculator to manage the human failure events (HFEs) and to calculate the diagnosis human error probabilities and execution human error probabilities.

This paper introduces the development process and an overview of a standard HRA method. The study was carried out in three stages; 1) development of the procedures and rules for a standard HRA method, 2) design of database schema, 3) implementation of graphic user interface and calculation logic of HRA calculator.

2. Standard HRA method

In the standard method, it is assumed that human error probability can be assessed by analyzing diagnosis part and execution part separately. And the method separates human tasks of NPPs into pre-initiating and post-initiating HFEs. Pre-initiating HFEs are the human errors which are occurred in daily routine tasks such as tests, maintenances and calibrations during normal operation. That kind of routine tasks are performed based on procedures and pre-defined task plan, so the role of diagnosis part of human behavior is almost negligible. Therefore diagnosis error does not need to be assessed for the pre-initiating HFEs. On the other hand, human tasks related to post-initiating HFEs need both parts of human behavior, diagnosis and execution. According to the human behavior model, the standard method has two separate analysis processes for pre-initiating and post-initiating HFEs.

The Figure1 shows the framework of the standard HRA method. The standard HRA method explicitly provides all kinds of rules and decision information needed to do HRA. It covers the dependent analysis of HRA.

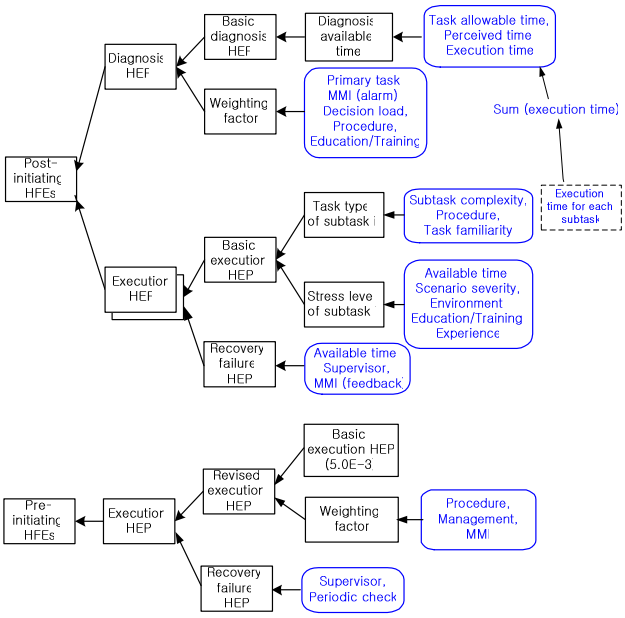

Figure1. Framework of the standard HRA method

3. Development of HRA Calculator

3.1 Database design

We designed four main tables to store human reliability analysis data into the database to meet the requirement of HRA calculator system. It consists of basic HFE table, diagnosis human error table, execution human error table and sub tasks table of execution human error.

The basic HFE table includes basic information such as event, scenario, analysis and review information. The diagnosis HE table includes the information related with diagnosis actions. It consists of task allow time, cue/alarm information and some weighting factors such as MMI, education level, etc.

The execution HE table stores basic execution information and subtasks of execution activities. We classified the following data to build the database schema.

[BASIC Human Failure Event]
-Event Info (Event name, description, type)
-Scenario (description, sequence)
-Task Info (frequency, procedures, etc)

-Remarks (analyst, analysis date, reviewer, review date)

[Diagnosis Human Error]
-Task allowable time
-Cue/Alarm (time, recognition time)
-weight factor (MMI, decision load, education/training, Procedures)

[Execution Human Error]
-Basic (education/training, procedures)
-Subtasks (task name, Equipment, worker, place)
-Subtask Type (complexity, procedure, task familiarity)
-Stress level (available time, scenario severity, Environment, Experience, education/training)

Figure2 shows the entity relation diagram of human reliability analysis supporting system. The EventID is the primary key to ensure uniqueness of the records and is used to join with other tables.

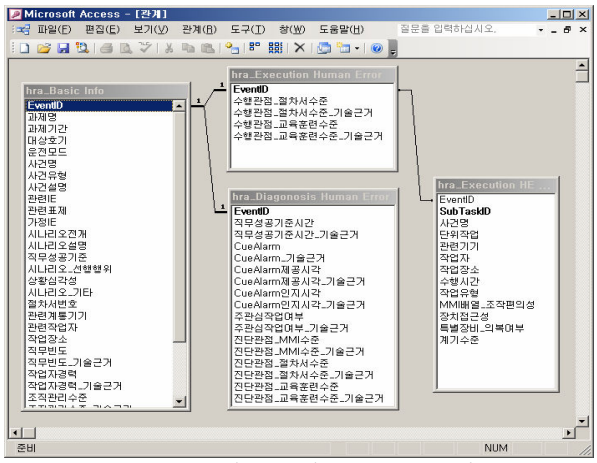

Figure2. Database Schema & E-R Diagram

3.2 development of HRA calculator

We designed the user interface of HRA calculator to input the analysis data and output the results. The HRA calculator consists of event manager, basic event general information editor, diagnosis human error editor, and execution human error editor. Each form stores essential human failure events to calculate the human error probabilities.

The event manager is the main form to manage the human failure events and shows the basic information of human failure events such as event name, event type, event scenario, and etc. The basic event editor includes the general information of selected HFE. The diagnosis human error editor and execution human error editor was developed to manage the diagnosis and execution human failure data and to calculate the human error probablities.

The figure3 shows the screen shot of HRA calculator.

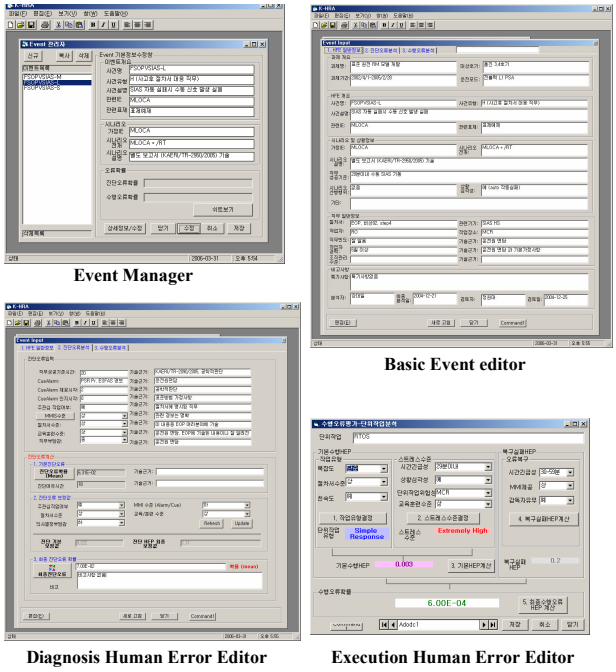

Figure. 3 HRA Calculator

4. Conclusion

This paper presents the standard HRA method and the design of database schema and the development of a HRA Calculator. The standard method focuses on standardizing the process and decision rules to minimize the uncertainty caused by HRA analysts. KAERI used the standard method to perform HRA for upgrading the KSNP PSA model. The Implementation of HRA calculator is under developing with visual basic and Microsoft access database. The HRA calculator will be a good supporting tool to help the analysts to evaluate the human reliability analysis of KSNP PSA model.

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