The Full Power HRA calculator development 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

The quality of a probabilistic safety assessment (PSA) has become more important. As part of enhancing the PSA quality, KAERI is developing the full power 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 system structure, 3) development of the HRA calculator.

2. The overview of a Standard HRA

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.

3. Development of HRA Calculator

The Figure2 shows the sample of traditional HRA input worksheet and calculation worksheet. The input worksheet consists of general information of basic event and diagnosis input data and execution input data of the human failure event. The output calculation sheet shows the calculation results of Human Error Probability of diagnosis and execution. The objective of HRA calculator development is to support automation of HFE calculation and to manage the various data which is generated as the results of HRA process. In order to meet the requirement of the HRA calculator, we developed the system with following procedure.

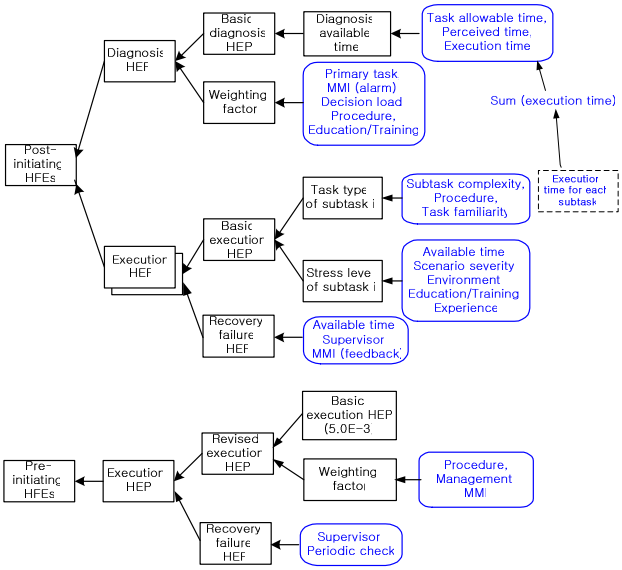

Figure1. Framework of the standard HRA method

Figure2. HRA Input and calculation sheet example

3.1 Software Design Requirements

The Software design requirements of HRA calculator are as follows:

The HRA calculator supports

- Automatic HEP (Diagnosis and Execution Human Error Probability) Quantification
- Information Database of all HRA diagnosis and execution activities.
- Standard HRE analysis method
- QA and documentation

3.2 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.

[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)

3.3 development of HRA calculator

We developed HRA calculator to store human failure events and to help the analyst to quantify the Human Error Probability of diagnosis and execution. The HRA calculator consists of event manager, HFE event editor, diagnosis and execution analysis tool, and HEP quantification tool. Each tool 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 HFE event editor includes the general information of selected HFE. The diagnosis and execution analysis tool is developed to manage the diagnosis and execution human failure data and to calculate the human error probabilities. The HEP quantifiation tool calculate the HEP of diagnosis and execution of selected HFEs.

The figure3 shows the screen shot of HRA calculator.

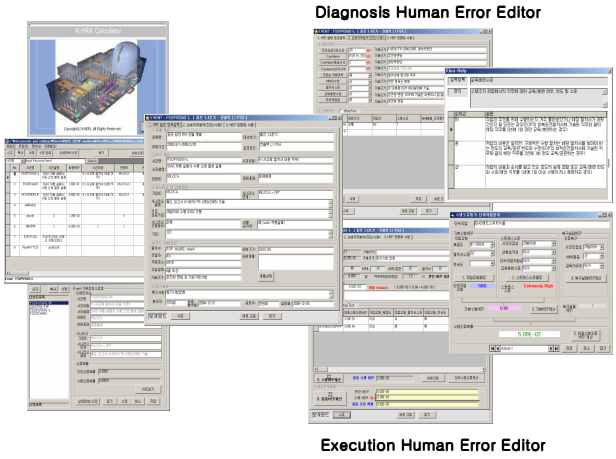

Figure. 3 The HRA Calculator

4. Conclusion

This paper presents the standard HRA method 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 developed with MS visual basic and Microsoft access database. At this time, the HRA calculator supports full power and post-initiating human failure events and but we are trying to extend this tool for lower power shutdown and pre-initiating human failure events. 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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