NRRC HRA upgrading, and research plan of HRA method development for extreme condition

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Nuclear Risk Research Center (NRRC) started to develop the HRA implementation guide what adapting the concept of "Narrative" approach for the qualitative analysis by IDHEAS[1] (the Integrated Decision-Tree Human Event Analysis System, NRC, draft report, 2013), and using the HRA Calculator[2] to quantitative analysis, for improving human reliability analysis (HRA) of Japanese nuclear power plants. The results of recent HRA studies, the importance of "Narrative" is emphasized. "Narrative" provides detailed explanation of the actual situation in the field to develop an understanding on the basis of time sequence, psychological impact elements such as including of environment and events in accordance with the situation of the scenario. Therefore, it is the process necessary to support HRA implementation regardless of the type of HRA quantification method to be used. This paper describes the overview of the HRA guidelines of NRRC, and the future research plan of the upgrading HRA for the HFE under the extreme conditions scenarios.

I. INTRODUCSION

In Japan, the estimation method of human error probability (HEP) has been used only THERP[3] (the Technique for Human Error Rate Prediction, NUREG / CR-1278). But, understanding of the context that leads to failure in the process of the task is important in the evaluation of cognitive and diagnostic failure. CBDTM[4] (the Cause-Based Decision Tree Method) is one of methods of representing context which leads to errors in the human tasks using decision trees, and it was included in the EPRI HRA Calculator. Furthermore, recently in the United States, the Integrated Decision-Tree Human Event Analysis System (IDHEAS), which brings together ideal aspects of previous multiple HRA approaches, is under development jointly by the NRC and EPRI. IDHEAS is a method that stresses context and task analysis and uses combinations of multiple decision trees in which operation teams (crews) end up making errors. Currently, efforts are being made to improve task analyses and qualitative analyses of implementation processes.

According to the results of recent HRA studies, the importance of "Narrative" is emphasized. "Narrative" provides detailed explanation of the actual situation in the field to develop an understanding on the basis of time sequence, psychological impact elements such as including of environment and events in accordance with the situation of the scenario. Therefore, it is the process necessary to support HRA implementation regardless of the type of HRA quantification method to be used.

Nuclear Risk Research Center (NRRC) started to develop the HRA implementation guide what adapting the concept of "Narrative" approach for the qualitative analysis by IDHEAS, and using the HRA Calculator to quantitative analysis, for improving human reliability analysis (HRA) of Japanese nuclear power plants. The NRRC HRA guidelines presents the converting method from the results of the "Narrative" to input data of HRA Calculator for quickly update the HRA of Japanese plants. On the other hand, it has been recognized to need the new approach of quantification method that replaced current methods (THERP, CBDTM, etc.) for the HRA under extreme conditions.

The development process of the NRRC HRA guidelines and the future of the research plan of the HRA of the HFE under the extreme conditions are shown in Figure 1.

Action Items	JFY2015	JFY2016	JFY2017	JFY2018	JFY2019
NRRC HRA Guidelines (Internal Event PRA, Narrative and HRA Calculator)	Draft Ver. Guideline	[1st Ver.] NRRC tech review Utility user review	Considering the Decision Tree extension		
Extreme conditions HRA (Narrative Trials, Quantification Methods, Guidelines,)		Narrative Dev. for Extreme Accidents (Fukushima Dai-ichi)	(Onagawa, Le Blayais) Identify HFE, Narrative	Conceptual design of HRA Methods	Detailed design of HRA Methods
Developing HFE Database (Actual HFE data collection, DB Items and context under the extreme conditions)		Conceptual design for HFE DB (with Utilities)	Sample content and DB format	Test operation & Feature analysis	Feature analysis

Fig. 1. HRA research roadmap of NRRC

II. NRRC HRA guidelines adapting the concept of narrative approach

The implementation steps in the NRRC HRA guideline shown in Fig.2.

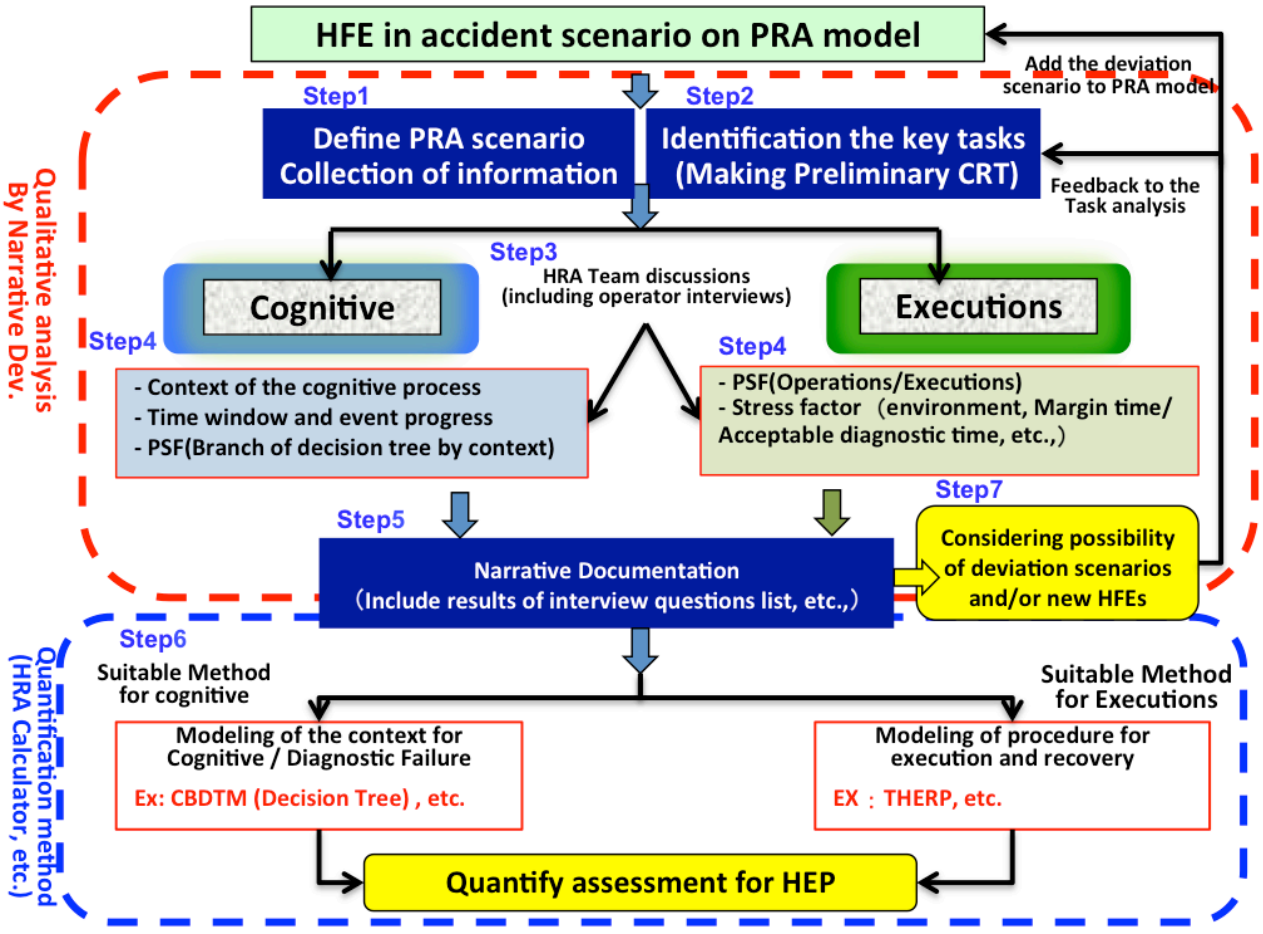

Fig. 2. Overview of NRRC HRA Implementation Guide (with Narrative Development)

- Step 1. Define a base/reference case scenario for each PRA scenario (including the collection of information)

- Step 2 . Perform a preliminary review that is based on information from an existing PRA by the PRA analyst. (Preliminary consideration of Crew Response Tree (CRT); identification of key tasks and subtasks)
- Step 3 . HRA team discussions (Including Operator Interviews) for narrative: Prepare for interviews (Customized questions list for the analysis of HFE, etc.), and interview with operation training instructors (or operators) for considering the HFE for base case scenario or complicating factors / scenario deviations.
- Step 4 . Analyze the results as input data for Failure Mechanisms of HRA Calculator. (Default Crew Composition, Time analysis, Cognitive Unrecovered, Cognitive Recovered, Execution PSFs , Stress Factors)
- Step 5 . Narrative Documentation (include results of interview questions list, Plant information, etc.,)
- Step 6. Quantify HEP in Base Case (by HRA Calculator)
- Step 7 . Consider possibility of deviation scenarios and/or new HFEs from the results of Steps 4 and 5.

(If necessary: Narrative development for deviation scenarios, Feedback the results to PRA Models)

When developing the narrative, the most important process is to ascertain and reflect the circumstances of tasks, which may be performed when an actual HFE arises, through interviews with operators and instructors other than those whose specialize in HRA or PRA. For this reason, information that will provide the input data necessary for the quantification methods should be reliably included in questions for conducting interviews.

Table I provides general examples of questions (partly) that will be necessary in interviews in cases where the HRA calculator is utilized for quantification in the process of developing the narrative.

TABLE I. List of Questions for Operators (Partly) (Including Effects on Analysis Results and Related Items)

No	Hearing items
- Questions used to understand the information necessary to decide the bifurcation of the CBDTM Decision Tree	
13	When the cue necessary for implementing the applicable operation is given to the operators, is the workload on the operators high or is there a confusion? (High workload or confusion decreases the operator's attentiveness (oversight in verifying necessary information))
14	Is it enough to verify the parameters necessary for implementing the applicable operations once, or must the parameters be monitored continuously?
15	Can the operator verify the parameters required for implementing the applicable operations from the front of the control panel, and need not leave the area in front of the control panel?
16	(Question necessary if the response to any of the following questions is YES - work load is high or there is confusion when the cue is given out in No.13, continuous monitoring is required in No.14, and the operator needs to move away from the panel for verifying the parameters in No.15) Is the cue necessary for implementing the applicable operation an alarm or the monitoring of instruments?

III. The development of new guidelines for HRA under extreme conditions

In the 2016 fiscal year, NRRC will developed the Narrative of the Fukushima Dai-ichi accident using the qualitative analysis process of NRRC HRA guidelines,

And, NRRC research program is as follows for the HRA under the extreme conditions.

- Study of HRA method for the seismic / Tsunami accident management (and mobile equipment, etc.).
- List up the mobile equipment that should be evaluated in HRA.
- Trial evaluation for typical mobile equipment (Select the 2 equipment) by NRRC HRA Guidelines.
- Extract the points to consider when applying the HRA Calculator for mobile equipment.
- Considering the new branch / model of Decision Tree, propose a partial extension of CBDTM.
- Getting more understanding for the human failure events by the expert meeting of HEP value for the decision tree and context for Japanese plants.

IV. Developing Human Failure Events Database

It will be apply the consideration of decision tree revising for HRA and analysed training results by collecting and sharing the HFE data from utilities.

NRRC aggregates the needs of the utility in order to design the concept of HFE DB.

Needs from utilities:

- Unsafe incidents information from the plant simulator training (operation during the accident).
- Unsafe incidents information from the emergency training, etc.
- Human error data on plant shutdown (caused by events of the Shutdown PRA, such as water leakage from the pressure vessel).

Analysis items from data of the plant simulator training are the following:

- Investigate the situation about organizing training results.
- Determine the framework of data collection should be organized.
- Consideration of the application of the data collection framework of SACADA[5] (the Scenario Authoring, Characterization, and Debriefing Application database).

Human error data of the shutdown PRA is collected at the following points of view, and will be used for basic information for the conceptual design of HFE database.

- Identify the HFE that incorporates the current Japanese shutdown PRA.
- Aggregate the actual HFE information and the results of the narrative development.

V. CONCLUSIONS

NRRC HRA guideline of narrative approach for the qualitative analysis process has been developed. This approach is scheduled to apply to the HRA under extreme conditions PRA (Fire, Seismic, Tsunami, Multi units etc.,) on next step of our study. This paper described the overview of the HRA guidelines of NRRC, the future research plan of the upgrading HRA for the HFE under the extreme conditions scenarios, and the developing our HFE database.

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