Development of a Human Error Analysis Program, COHEP

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1. Introduction

- Due to Chernobyl nuclear power plant (NPP) accident and TMI NPP accident which were caused by worsening human error, Human Reliability Analysis (HRA) has become increasingly important.
- The more reliable systems, structures and parts are emphasized, the human error will occupy a larger proportion of the risk.
- HRA identifies all possible human errors and quantifies the identified human errors.
- In this study, to make HRA more easily, COHEP (Calculator Of Human Error Probability) program which calculates the human error probability (HEP) was developed.

2. Method

- COHEP is based on NUREG/CR-6883 (Standard Plant Analysis Risk Human Reliability Analysis, SPAR-H). SPAR-H is the most recently developed human reliability analysis method by U.S. NRC. Also, SPAR-H is easy to use and uses a beta distribution for uncertainty analysis.
- COHEP calculates the HEP by dividing the diagnosis HEP and action HEP. To calculate the probability, a basic HEP value is used. A basic diagnosis HEP value is 1.0E-2 and basic action HEP value is 1.0E-3.
- The diagnosis HEP and action HEP are calculated in the same way. They are calculated by multiplying the each basic HEP by value of performance shaping factors (PSFs).
- PSF is any factor that influences human performance such as experience, workload, task complexity, etc. COHEP uses 8 PSFs which are shown in Table I.

PSFS	Available time, Stress and stressors, Experience and training, Complexity, Ergonomics and Human-Machine Interface, Procedures, Fitness for duty, Work processes

Table I : Performance Shaping Factors

- The calculation of HEPs in general HRA methods is shown as Fig. 1.

$$HEP_{diagnosis} = \text{Basic } HEP_{diagnosis} * PSF_{composite}$$

$$HEP_{action} = \text{Basic } HEP_{action} * PSF_{composite}$$
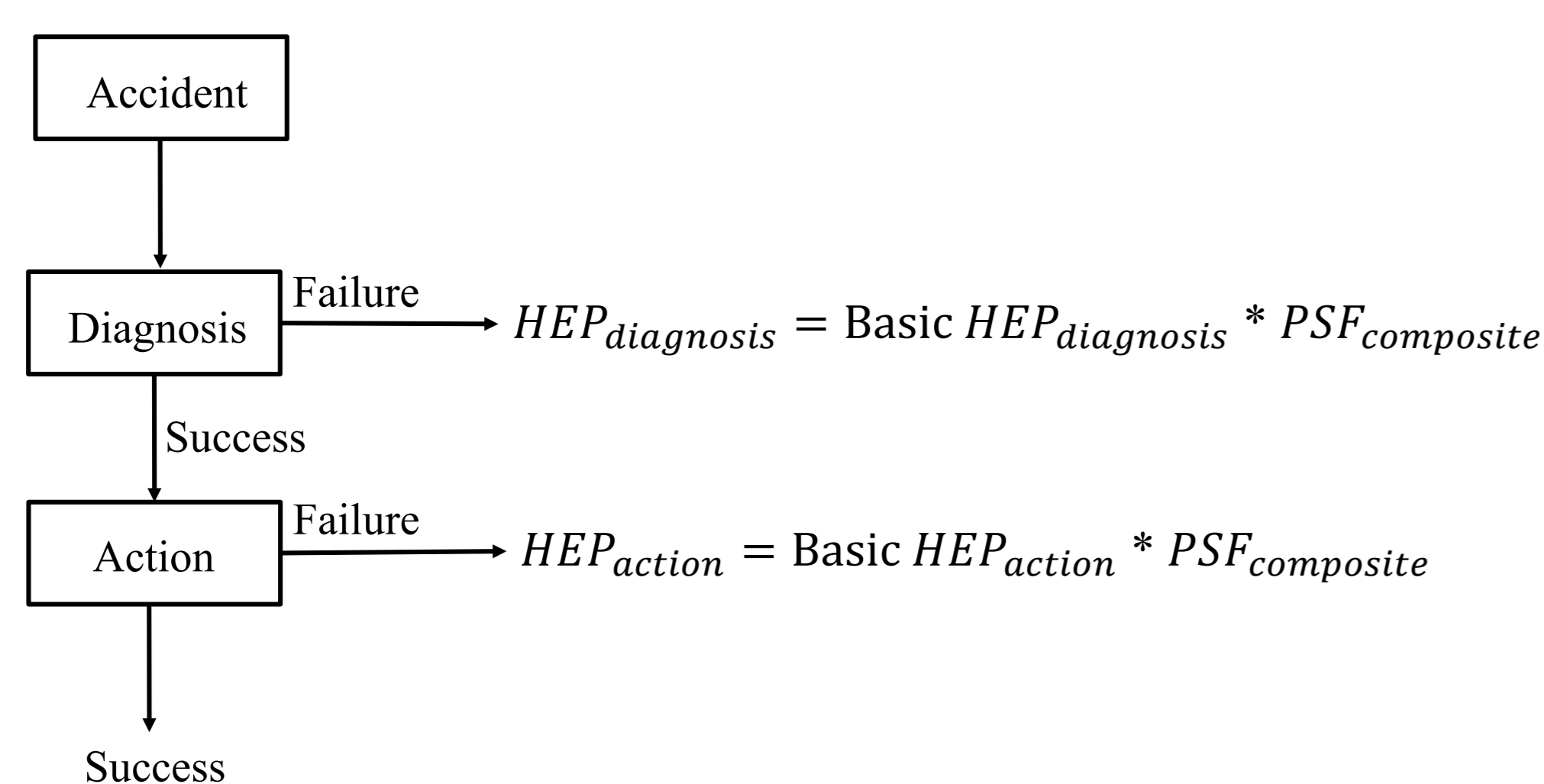
Fig. 1. Calculation of HEPs in general HRA methods

- Each PSF has a level and its own value. The level and value are set by the analyst who selects the appropriate element. When the value of PSF is greater than 1, it is called Negative PSF.
- The calculation depends on the number of Negative PSFs. If there are less than 3 Negative PSFs, the HEP is calculated by equation (1). If there are three or more Negative PSFs, the HEP is calculated by equation (2).

$$HEP = BHEP * PSF_{composite} \quad (1)$$

$$HEP = \frac{BHEP * PSF_{composite}}{BHEP * \left(PSF_{composite} - 1\right) + 1} \quad (2)$$

- PSF composite means the multiplication of PSF values.

3. Description

- COHEP provides a format worksheet for an analysis. It is possible to three analyzes by using worksheet. The three analyzes are shown in Table II.

Mode	Both Diagnosis and Action, Only Diagnosis, Only Action

Table II : the analysis mode of COHEP

- In the worksheet, basic description about the event can be entered and the PSF levels can be selected.
- The basic description consists of the name of NPP, the initiating event (IE), the basic event, the basic event context, the basic event description.
- Fig. 2. is the sample case about the basic description.

Fig. 2. Sample case about the basic description

- Among PSFs, when available time and average time or time required are inputted, COHEP suggests appropriate values for PSF levels of Available Time. Fig. 3. is the suggestion of COHEP.

Fig. 3. Suggestion about Available Time by COHEP

- Excluding Available Time, the remaining seven PSFs can select only fixed levels.
- The reason for selecting the level of each PSF can be entered in the comment field.
- Fig. 4. is the result screen about a sample case.

Fig. 4. Result screen about a sample case

4. Conclusion

- COHEP, which is based on SPAR-H, calculates diagnosis HEP and action HEP. This program not only reduces the time spent on calculations, but also avoids concerns about calculation mistakes.
- Now, COHEP is only able to calculate HEP for one action per diagnosis.
- Later, the function of calculating HEP by adding multiple actions and the function of calculating dependency should be supplemented.
- Also, if the function of reflect HEP connections between units is added, it is possible to make single unit PSA and multi-unit PSA more easily.

5. Acknowledgement

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