Development of a Human Error Analysis Program, COHEP

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1. Introduction

The Chernobyl nuclear power plant accident and the TMI nuclear power plant accident were caused by worsening human error. As such, it can be seen that a human error has a great influence on the safety of nuclear power plants. In general, the risk of a nuclear power plant is evaluated by simulating the accident situation through the event tree and the fault tree. A human error is also included as a factor in the fault tree.

Human Reliability Analysis refers to identifying all possible human errors in the course of an accident and quantifying the identified human errors. Human abilities are different every day and every hour, and the degree of human tension and interactions with colleagues are mostly psychological, so the probability of human error is highly uncertain. Nevertheless, the reason human error is included in the risk assessment is that the more highly reliable systems, structures and components are emphasized, the greater the proportion of the risk will result from human error. For this reason, human reliability analysis is essential.

Since the Fukushima accident, interest in multiple accidents has increased. Most operating multi-unit sites share common operating practices and operator behaviors and have procedural and organizational similarities. Due to this sharing and similarity, human error may also be related to the duration of the site. Therefore, the correlation between the probability of human error in the number of units in the site is reflected in the PSA.

As described above, human reliability analysis is an important issue for both single unit PSA and multi-unit PSA. In order to calculate the human error probability when analyzing the risk of a nuclear power plant, a program (Calculator Of Human Error Probability, COHEP) was developed that calculates the human error probability and reflects the relationship between the human error probability between several units.

2. Methodology of the program

There are several human reliability analysis methods such as THERP, ASEP and HCR. COHEP is based on NUREG/CR-6883 (Standard Plant Analysis Risk Human Reliability Analysis, SPAR-H) among several methods. SPAR-H has some characteristics. One is the most recently developed human reliability analysis method by U.S. NRC. The others are it is easy to use and uses a beta distribution for uncertainty analysis.

COHEP calculates the human error probability(HEP) by dividing the diagnosis HEP and action HEP. To calculate the probability, a predefined basic HEP value is used (Basic Diagnosis HEP : 1.0E-2, Basic Action HEP : 1.0E-3). Diagnosis and Action HEP is calculated by multiplying Basic Diagnosis and Action HEP by value of performance shaping factor(PSF). PSF consists of 8 elements. The elements of PSF are shown in table I.

Table I : Performance Shaping Factors(PSFs)

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

Each PSF has a level and the PSF value is set by selecting an appropriate level. When all appropriate values have been assigned, the HEP is calculated. Before calculating the HEP, it is essential to figure out how many items have a PSF value greater than 1. When the value of PSF is greater than 1, it is called Negative PSF. 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. Program 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.

Table II : the analysis mode of COHEP

Mode	Both Diagnosis and Action, Only Diagnosis, Only Action

In the worksheet, basic description about the event can be entered and the PSF values can be selected. The basic description consists of the name of nuclear power plant, the initiating event, the basic event, the basic event context, the basic event description. Among PSFs, when available time and average time or time required are inputted, COHEP suggests appropriate values for PSF levels of Available Time in consideration of the input values. Excluding Available Time, the remaining seven PSFs can select only fixed levels. COHEP counts the number of Negative PSFs according to the PSF value selected by the user. Diagnosis or Action HEP is

calculated using equation (1) or (2) depending on the number of Negative PSFs. The result screen is show in Fig. 1.

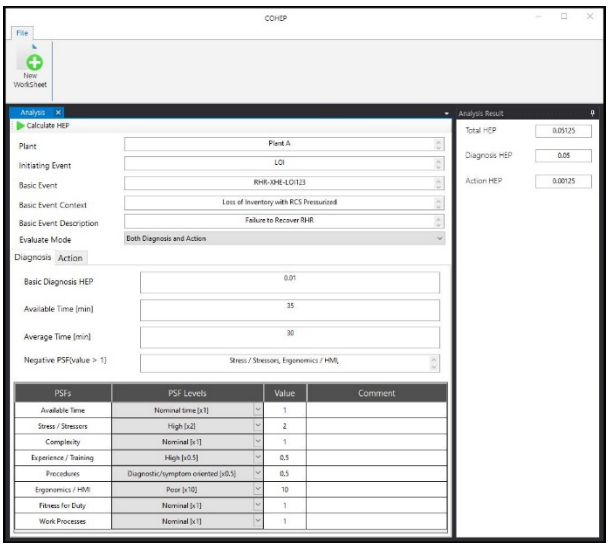

Fig. 1. COHEP result screen part 1.

4. Conclusions

For Human Reliability Analysis, even if each analyst uses the same method, the analysis results may be different. This is also a factor that can degrade reliability. Reliability can be guaranteed by applying the latest method and ensuring consistency.

Since COHEP is based on SPAR-H, it provides the formal worksheet to calculate the human error probability. It can ensure the consistency of analysis. SPAR-H has a calculation task and a calculation error may occur in the step of manually calculating HEP by humans. In addition, it takes time to calculate. COHEP not only reduces the time spent on calculations, but also avoids concerns about calculation mistakes.

Currently, COHEP is only able to calculate HEP for one action per diagnosis. The function of calculating HEP by adding multiple actions and the function of calculating dependency should be supplemented. If additional necessary matters are supplemented, it will be possible to facilitate Human Reliability Analysis in Single-unit PSA and Multi-unit PSA.

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REFERENCES

[1] US NRC, The SPAR-H Human Reliability Analysis Method, NUREG/CR-6883, 2005

[2] Awwal Mohammed Arigi, Human and organizational factors for multi-unit probabilistic safety assessment: Identification and characterization for the Korean case, NET, 2019

[3] 제무성, 계통신뢰도공학, 시그마프레스, 2014

[4] Korea Atomic Energy Research Institute, Development of A Standard Method for Human Reliability Analysis (HRA) of Nuclear Power Plants, 2005