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A Study on Rating of AOP (Abnormal Operation Procedure) Based on Difficulty, Importance, and Frequency

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1. Introduction

The number of abnormal operation procedures (AOPs) has been increased as operators establish AOPs additionally to reflect plant operation experience in domestic plants. There exist plants those have more than one hundred AOPs. Therefore operators have started to recognize the importance of classifying AOPs. They have tried to classify the abnormal events related to AOPs based on how urgently they need to be restored by expert's opinion [1].

The purpose of this paper is to prioritize AOPs for ① training and ② effective operation. An effective operation means an enhancement of operational safety by managing and/or keeping in mind AOPs related to abnormal events that are more important and occur more frequently. We perform a rating of AOPs based on difficulty (D), importance (I), and frequency (F). A DIF analysis based on how difficult the task is, how important it is, and how frequently they do it is a well-known method of assessing performance, prioritizing training needs and planning [2].

In this paper, we suggest two kinds of measures of prioritizing AOPs for effective operation purpose and training purpose. Training experts have applied a DIF analysis for the development of AOP training program in Korea [3]. We expand the number of operators surveyed significantly to increase the reliability of the survey results. The results from two kinds of measures will give information for an effective operation and training scheduling. It can also be used for cross-checking against the existing AOP classification results to take emergency measures.

2. Methods and Results

2.1 Data collection for D, I, and F

To collect D and I data a survey targeting twelve MCR operation crew of a reference plant was carried out. We drew up a questionnaire in which each AOP is scored on a scale of one to five for D and I respectively. We calculated the mean of D and the mean of I for each AOP from the survey results. We use terms "D-value" and "I-value" instead of the mean of D and I. For the F-value, we applied the existing research results. The F-value collected from the Korea Nuclear Information System (KONIS) has a score of one to five, where each score has the following meaning:

1: the event occurred more than ten years prior
2: the event occurred within ten years
3: the event occurred within five years
4: the event occurred within two years
5: the event occurred within one year

2.2 Measures for Rating AOPs

Figure 1 shows the boxplot of the D-value, I-value, and F-value. Compared to the D-value and I-value, the F-value is distributed in a different pattern.

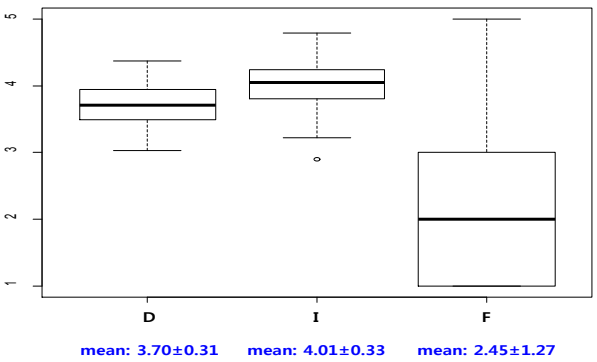

Figure1. Boxplot of D-value, I-value and F-value

It is easy to be controlled by the F-value when we use the mean of the D-value, I-value, and F-value of each AOP as a measure of AOP priority. Therefore, we standardized the three kinds of data respectively. We called them as SD-value, SI-value, and SF-value. Standardization is well known for rescaling data. It transforms data to have zero means and unit variance.

In this paper, we suggest two kinds of measures for rating of AOPs. They are the mean of the SD-value, SI-value, and SF-value (SDIF-mean) to prioritize AOPs for the training scheduling and the mean of the SI-value and SF-value (SIF-mean) for an effective operation. D is ruled out for the measure of prioritizing AOPs for an effective operation since no matter how difficult it might be, operators should perform an appropriate AOP to restore under an abnormal situation.

$$SDIF\text{-}mean = (SD\text{-}value + SI\text{-}value + SF\text{-}value)/3 \quad (1)$$

$$SIF\text{-}mean = (SI\text{-}value + SF\text{-}value)/2 \quad (2)$$

2.3 Results

Figure 2 shows SD-value, SI-value, and SF-value per each AOP. We can see a relative rate of D, I, and F per each AOP and which one has a high score on D, I, and F among AOPs. Figure 3 shows line chart for SDIF-mean and SIF-mean.

We classified the AOPs of a reference plant into four groups for operation and training respectively by rank of SDIF-mean and SIF-mean. Table 1 shows the criterion of each group and the percentage of the AOPs in each group. Groups A, B, C, and D are for a training scheduling and groups A′, B′, C′, and D′ are for effective operation. μ and σ represent the mean and the standard deviation of SDIF-mean while μ' and σ' represent those of SIF-mean. We can prioritize AOPs for an effective operation and training based on the classification.

Table1. Classification of AOPs for Effective Operation and Training

	Group	Criterion	%
For Effective Operation	A	μ+1σ < SDIF-mean	16
	B	μ < SDIF-mean ≤ μ+1σ	42
	C	μ-1σ <SDIF-mean ≤ μ	27
	D	SDIF-mean ≤ μ-1σ	16
For Training	A′	μ′+1σ′ < SIF-mean	17
	B′	μ′ < SIF-mean ≤ μ′+1σ′	34
	C′	μ′-1σ′ < SIF-mean ≤ μ′	34
	D′	SIF-mean ≤ μ′-1σ′	16

3. Conclusions

In this paper, we suggested two kinds of measures of prioritizing AOPs based on D, I, and F. One is for effective operation and the other is for the training scheduling. We collected D and I data from a survey and F data from the KONIS. We classified AOPs into four groups by rank for training and effective operation. The results will give information for modifying the exiting AOP training schedule and for managing AOPs intensively that are more important and more frequently performed by operators.

REFERENCES

[1] Korea Hydro & Nuclear Co., "Operation procedure for Shinkori #2 plant," Rev.0. 기행-2001-09, 2001.
[2] John A. Yoder "Training program handbook: A systematic approach to training," DOE-HDBK-1078-94, 1994.
[3] Korea Hydro & Nuclear Co., "Task-to-training matrix for YGN 2,3 plants," 2011-50011863-단-0782, 2011.

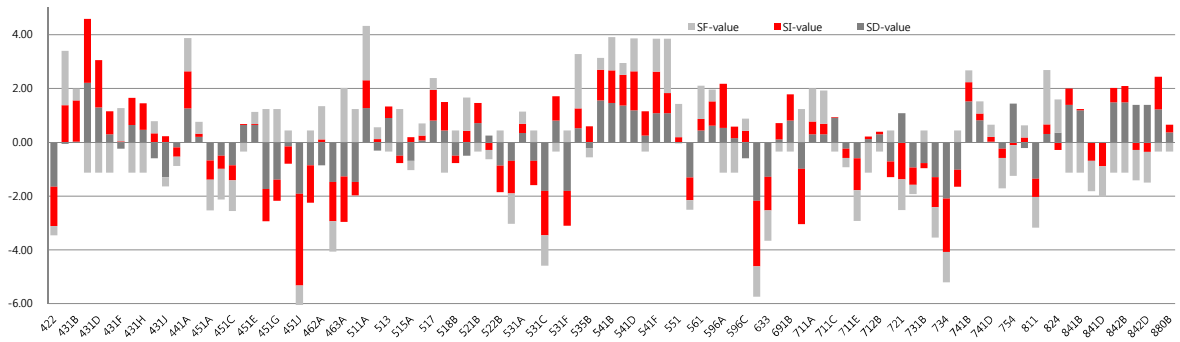

Figure 2. Bar Chart of SD-value, SI-value, and SF-value

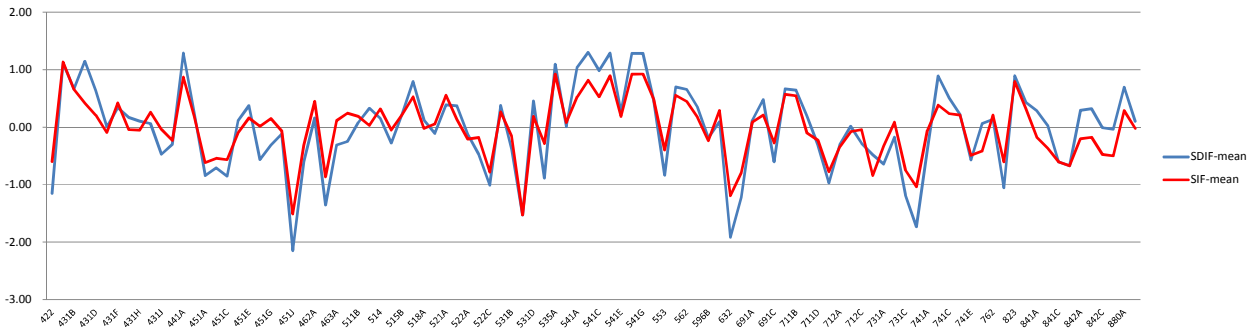

Figure 3. Line Chart of SDIF-mean and SIF-mean