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A Study on the Acceptance Criteria for ΔTrip Frequency

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1. Introduction

Many risk informed regulation & applications (RIR&A) are approved, and more RIR&A will be actively applied in Korea. The acceptance criteria for the RIR&A have been ΔCDF, and ΔLERF[1]. However, in the economical point of view, the change of the reactor trip frequency (hereafter, it is called Δtrip) are important element to monitor in the RIR&A.

A reactor trip causes a huge economical loss, and causes a bad reputation in the social acceptance which causes eventually a social cost, and could induce a safety problem by giving a severe stress on the operators.

Usually, the chief managers of nuclear power plants are reluctant to increase the trip frequency by a RIR&A, even though the RIR&A could bring an economical benefit, and could not threaten the safety. Because, if a reactor trip occurs, it would be reflected in his performance assessment.

Therefore, it is necessary to set up an acceptance criteria for Δtrip in the RIR&A without depending on the personal preference of the chief manager.

This paper introduces the acceptance criteria for Δtrip in the RIR&A.

2. The Acceptance Criteria of ΔTrip.

2.1 A Rule of ΔTrip.

Let's define that $\Delta trip^{app}$ is the Δtrip caused by performing a RIR&A, and $\Delta trip^{avg}$ is the increased trip frequency when the trip frequencies of each transient initiating events are increased according to the CDF contribution portion of initiating events until the acceptable maximum CDF is reached without changing the LOCA variables. The following rule could be derived;

Step 1: A RIR&A is acceptable if

$$\Delta trip^{app} < 0.1 * \Delta trip^{avg} \quad \text{-------- (1)}$$

Step 2: If Step 1 is not satisfied, then the advantage of RIR&A should be proved economically, or by others. For example, if the advantage of RIR&A is more than twice as much as the economical loss, the RIR&A would be acceptable.

2.2 Example of the Rule

When UCN Unit 3 ESW A Pump is out of service for on-line maintenance(OLM), △CDF and $\triangle Trip^{App}$ are 1.8×10^{-8}/yr and 0.0157/yr, respectively (See Table 1).

Since the current CDF of UCN 3 is 5.41×10^{-6}/y, the maximum possible acceptable △CDF is 10^{-6}/yr (refer to RG 1.174). Thus, if the frequency of trip increases without changing the LOCA variables until CDF becomes $6.41x10^{-6}$/y, according to the contribution portion of initiating events in the CDF, the results are shown in the Table 2.

Table 1. △$Trip^{App}$ with ESW A Pump Out of Service

	Normal	ESW A Pump OOS	ESW A Pump OOS for 14 days
LOCCW freq	0.3904/yr	0.4061/yr	
CDF	5.407e-6/yr	5.425e-6/yr	
ΔCDF		1.8e-8/yr	
ΔTrip freq		0.0157/yr	
ΔTrip #			0.0006

Table 2. The increased Trip frequencies reflecting CDF contribution portion of initiating events

Initiating Event	Freq(#/yr)	Initiating Event	Freq(#/yr)
GTRN	1.15	Loss of Condenser	$5.94x10^{-2}$
Loss of Main Feedwater	$1.02x10^{-1}$	LOOP	$3.43x10^{-2}$
Loss of AC bus	$2.91x10^{-2}$	Loss of DC bus	$2.06x10^{-2}$
Loss of Instr Air	included in GTRN	Loss of CCW	0.473
SGTR	$8.60x10^{-3}$		

Since the trip frequency is 1.86/yr in Table 2 while it was 1.53/yr in the previous calculation, total △$Trip^{avg}$ is 0.33/yr.

Thus,

$$\triangle Trip^{App} = 0.0157/yr \quad < \quad 0.1*\triangle Trip^{avg} = 0.033/yr$$

Therefore, ESW A Pump OLM would be approved.

As shown in Table 1, since ESW A Pump 14 day OOS could corresponds to 0.0006 days reactor trip. Thus, if one day generation loss costs one million dollar, and if it takes 3 days to return to the normal operation after reactor trip, the possible generation loss;

0.0006 x $1,000,000/day x 3days = US$ 1,800

The advantage of ESW A Pump OLM is;

1) an efficient use of maintenance resource
2) the reliability improvement of ESW A pump
3) the curtailment of refueling period

Thus, by simple calculation considering only the effect 3), if the refueling period could be shortened roughly 2.6 minutes, then the OLM have an economical advantage.

3. Conclusions

When RIR&A is performed, Δtrip acceptance criteria are proposed as a rule instead of a value. In the utility point of view, Δtrip acceptance criteria would be useful

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REFERENCES

[1] USNRC, "An Approach for Using PRA in Risk-Informed Decisions on Plant Specific Changes to the Licensing Basis. Plant Specific", RG 1.174, NRC, 1998