Case study and considerations on implementation of NEI 00-04 using MPAS

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1. Introduction

The NRC has proposed 10 CFR 50.69 (1995) which establishes special treatment requirements for plant SSCs with respect to risk-informed categorization. And the trial regulatory guide 1.201 (Rev. 1, 2006) provided the NRC staff's regulatory positions on NEI 00-04 (Rev. 0, 2005) [1].

In this study, recent status of 10 CFR 50.69 Option 2 implementation was surveyed. And related regulations and guidelines were reviewed and analyzed in order to prepare regulatory provisions and evaluation guidance to 10 CFR 50.69 Option 2 implementations. In example, a case study of preliminary SSCs categorizations was also performed for three systems in UCN, Units 3 and 4 using MPAS.

2. Recent status of 10 CFR 50.69 Option 2 implementation

In U.S.A, the NRC has approved a risk-informed process for determining the safety significance of SSCs as part of the Graded Quality Assurance (GQA) Program for South Texas Project, Units 1 and 2. It has been found that in practice, the GQA Program was limited in implementation by the special treatment requirements imposed by 10 CFR 21, 50, and 100 and others for SSCs that are safety related, important to safety, or otherwise within the scope of the regulations.

The pilot project for the rulemaking on risk-informing special treatment requirements in 10 CFR Part 50 (RIP 50 Option 2) was conducted. As the implementation of 10 CFR 50.69 would be voluntary, the BWROG initiated a pilot project for implementation of risk-informed categorization for the containment spray, standby gas treatment system and feedwater system in Quad Cities NPP. Through the WOG 10 CFR 50.69 pilot plant efforts, two systems (Containment spray and normal service water system) at Surry 1 unit and two systems (Chemical and volume control and feedwater system) at Wolf Creek have been categorized, these submittals and for NRC review and approval are in progress.

In Korea, a pilot study on applying 10 CFR 50.69 Option 2 to two systems (HPSI, ESW) in UCN Units, 3 and 4 was performed [2]. The results of 10 CFR 50.69 Option 2 applications show that many safety related SSCs can be treated with relaxed requirements in two systems, while relatively little non-safety related SSCs should be controlled with special treat requirements. This study proposed the Balancing method that could predict to be reasonable for the evaluation of importance measure of CCF RAW [3, 4]. For the selection of a SSC candidate for regulatory inspections, the JNES used a FV screening criterion, 0.001 in the trial identification of safety significant components with risk importance measures [5].

3. Case study of preliminary implementation of NEI 00-04

Preliminary SSCs categorization of three systems of UCN, Units 3 and 4 was performed by PSA of internal event at full power using MPAS in accordance with NEI 00-04, Revision 0 [6]. Three systems consist of containment spray system (CSS) as of a mitigating system, essential chilled water system (ECWS) as of auxiliary system and main feedwater system (MFWS) as of non-safety related system.

The categorization steps involved system engineering assessment, component safety significance assessment, defense-in-depth assessment and preliminary engineering categorization of functions. The first sensitivity analysis included the examination of variations (95^{th} and 5^{th} percentile) in human error probabilities and common cause failure (CCF) probabilities and variation in maintenance unavailability. The risk sensitivity study was performed by imposing increase in reliability of all SSCs subject to relaxation in special treatment of factors of 3 to 5. Two types of the sensitive study made no changes in categorization results and satisfied the acceptance criteria of the regulatory guide 1.174. But, it still requires detailed reviews in viewpoints of integrated decision-making panel (IDP), etc.

Table 1 and 2 show that it is found to be a candidate to be categorized as low safety significant for mini-flow path of CSS pump and backup path of RCS through internal event analysis of full power mode. As ECWS is shown to meet these NEI 00-04's threshold requirements, the entire system can be treated low safety significant. In contrast, all SSCs of MFWS modeled in MPAS are shown to be of high safety significance.

In case of decrease of a FV threshold value, 0.005 to 0.001, the number of SSCs categorized as RISC 1 and 2 had no change in this case study. For application of the Balancing method, it was represented that the number of SSCs categorized as

RISC-3 for the CSS could be slightly increased. The considerations on implementation of NEI 00-04 in this case study were derived as follows.

- Evaluation of risk importance of train and system level is more appropriate than that of component level itself in categorizing SSCs.
- The screening criteria are needed to categorize SSCs which are not explicitly represented in the risk model.
- It came up whether risk importance of SSCs should be also applied to other SSCs/functions (e.g., support systems, SSCs upstream or downstream, etc.)
- It requires more risk evaluations which covers LERF, external hazards and shutdown events.
- It is very important in appropriately selecting the thresholds of risk importance measure (FV and RAW).

Table 1. Preliminary SSCs categorization results of three systems of UCN Units 3 and 4

*Categorization	CSS		ECWS		MFWS	
	SR	Non-SR	SR	Non-SR	SR	Non-SR
Safety Significant	18	-	-	-	4	5
Low Safety Significant	12	-	36	-	-	-

* These categorization results of these systems included some SSCs only modeled in MPAS.

Table 2. Preliminary SSCs categorization results of containment spray system

System function	Each path	# of SSC	Cat. of RISC
Core spray during recirculation mode/ Containment isolation	A Path	6	RISC-1
	B Path	*4	RISC-3
	C Path	12	RISC-1
A heat sink in RCS	D path	8	RISC-3

* These components were explicitly not modeled in MPAS.

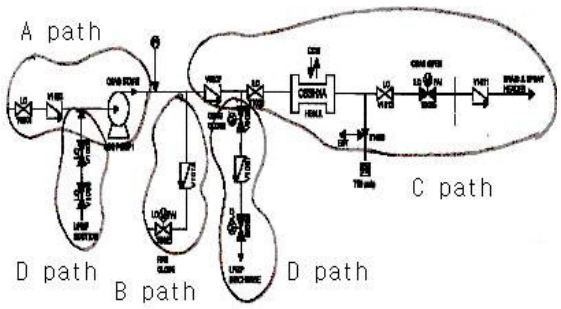

Fig. 1 Path identification for a train of CSS

4. The NRC's regulatory positions on NEI 00-04

The trial regulatory guide 1.201(Rev. 1) provides interim guidance for complying with the NRC's requirements in 10 CFR 50.69, by using the process described in Revision 0 of NEI 00-04 to determine the safety significance of SSCs and place them into the appropriate RISC categories [7].

- Risk evaluations and insights that cover the full spectrum of potential events and the range of plant operating modes
- Limited guidance for determining the technical adequacy attributes required for the hazard analyses, low-power and shutdown PRAs, or for non-PRA-type analysis
- Description of the impact of parameter and model uncertainties on the categorization
- Measures for preventing the emergence of extensive common-cause failures impacting multiple systems and significant unmitigated degradation
- Evaluation of all aspects of NEI 00-04 such as sensitivity study, IDP, the validity of the categorization process including the risk sensitivity study
- Specific clarifications for NRC endorsement of revision 0 of NEI 00-04
  - It is not to be understood to mean that deterministic or qualitative information should be used only when no PRA information exist.
  - The IDP review of risk information should address both active and passive functions and SSCs.
  - The NRC intends to impose a license condition that will explicitly address the scope of the PRA and non-PRA methods used in the licensee's categorization approach.
  - The cumulative risk increase from implementing of 10 CFR 50.69 should be maintained acceptably small.
  - The corrective action program should address the potential for SSC failures at different times resulting from a common cause

5. Conclusion

10 CFR 50.69 Option 2 related regulations and guidelines were reviewed and analyzed in order to prepare regulatory provisions and evaluation guidance to 10 CFR 50.69 Option 2 implementations. A case study of preliminary SSCs categorization was performed for three systems of UCN Units, 3 and 4 using MPAS in accordance with NEI 00-04 (Rev. 0). The considerations on implementation of NEI 00-04 were derived using the above results. It is expected that these results will contribute to the preparation of regulatory provisions to 10 CFR 50.69 Option 2.

REFERENCES

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