Development of Regulatory PSA Model of Kori Units 3,4 for a Risk Informed Regulation

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1. Introduction

The regulatory Level-1 internal probabilistic safety assessment (PSA) model (MPAS, multi purpose analysis safety) is developed to apply to risk informed regulation. This MPAS model could be applied to develop the index for a graded regulation and to perform the independent risk analysis of Kori units 3, 4 in KINS (Korea Institute of Nuclear Safety).

2. Development Kori Units 3, 4 MPAS Model

This study was composed of three steps. The first step was a review of the utility PSA Model, design and operation document and operating experiences. The second was the identification of the items to be modified from the first step processing. The last is the development the PSA model for Kori units 3, 4.

2.1 Utility PSA Model Review

From the review the utility PSA model, we have derived what items are to be improved based on ASME PSA standard. The design change items that could be impacted the PSA, were also investigated. The in-depth interview with a MCR (Main Control Room) shift operation team was performed. From this process, various items to be modified were evaluated as follows.

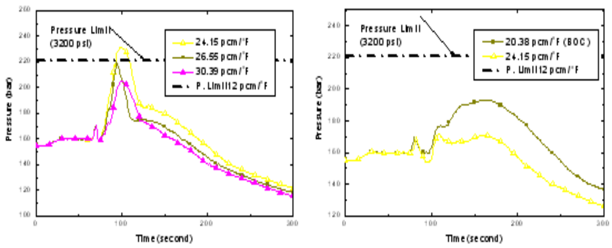
- Event Tree (ET) modification based on as built & as operated conditions are to be considered.
- The AAA DG is installed in Kori site is to be added into MPAS model
- Duplication of motive power of main steam & feed water isolation valves was added
- T/H analysis using best estimate program for success criteria is needed.
- New HRA(human error analysis) methodology is to be applied
- Domestic operation experiences are to be applied
- ATWS(Anticipated Transient Without Scram) ET is to be re-evaluated

2.1 MPAS PSA Model Development

The MPAS PSA model for Kori units 3, 4 is developed based on the review results in the former section.

The success criteria of the utility PSA model was determined based on the MAAP code. In the MPAS model, various T/H analyses for using a best estimate program (MARS) was performed for the success criteria.

In the ATWS ET of utility PSA model, the conservative assumption without the UET (Unfavorable Exposure Time) calculation was applied. In MPAS model for Kori units 3, 4, the UET calculation based on as operated condition was performed and the ATWS ET was modified based on this result. The UET due to turbine trip or non turbine trip is as follows.

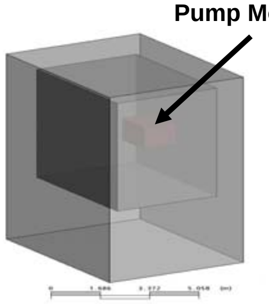


(1)Turbine Trip (2) Non Turbine

Figure 1 UET Calculation

To determine the operability of a component following a loss of a HVAC (heating, ventilation and air conditioning) in a pump room, the room temperature heat-up calculation was performed using the CFD (Computational Fluid Dynamics) program. The analysis model and result is as follows.

Pump Motor



		Calculation Documents	Current Study
CS Pump Room	Volume	5,760 ft3	4,680 ft3
	Heat Rate	61,800 Btu/hr	61,800 Btu/hr
AFW Pump Room	Volume	4,312 ft3	4,312 ft3
	Heat Rate	121,910 Btu/hr	120,956 Btu/hr

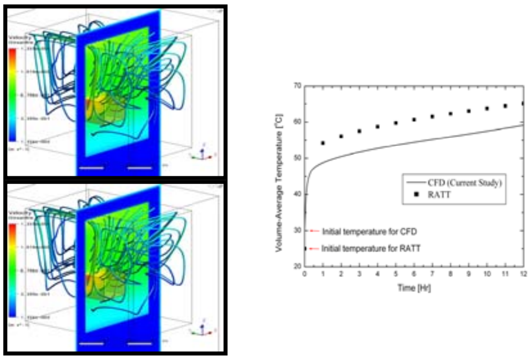


Figure 2 Room Temperature Heat-up Calculation Model input & Result

All of HRA data were examined using K-HRA methodology and the results are also applied in to MPAS model.

Various FT(fault tree) modesl were reviewed and modified based on design and operation condition as follows.

1) Safety Injection System
- Charging line isolation valve model was added
- The manual valve in recirculation line are added.

2) Auxiliary Feed Water Systeem
- The CCF (common cause failure) event between MDP (motor driven pump) & TDP (turbine driven pump) was deleted

3) Electrical Power System
- AAC D/G was added

Several ET are modified such as small LOCA (Loss of Coolant Accident), SGRT(Steam Generator Tube Rupture), LOOP(Loss of Offsite Power), SBO(Station Black Out) and ATWS. One ET(Loss of NSCW) is added. Two transients (General Transient and SBO) induced LOCA ETs are added also for the convenience of analysis.

Through a modification of the PSA model, MPAS model for Kori units 3, 4 has been developed and the CDF (core damage frequency) is 8.91 E-6/year. The CDF for each IE of the MPAS Model and the utility PSA model are presented in the following table respectively.

IE	CDF	
	MPAS Model	Utility PSA
Small LOCA	1.60E-06	1.43E-06
SGTR	1.47E-06	2.14E-07
Station Blackout (DG Run Failure)	1.04E-06	3.46E-06
Loss of NSCW	9.99E-07	N/A
Loss of a 125V DC Bus A	6.11E-07	4.49E-07
General Transients	5.43E-07	7.74E-07
Loss of CCW	5.01E-07	5.57E-07
Interfacing LOCA	3.25E-07	3.25E-07
Loss of Offsite Power	3.17E-07	1.64E-07
Medium LOCA	3.10E-07	1.16E-07
Vessel Rupture	2.66E-07	2.66E-07
Station Blackout (DG Start Failure)	2.62E-07	5.57E-08
Loss of MFW (Non Recoverable)	1.25E-07	N/A
Loss of IA	1.21E-07	N/A

3. Conclusion

The regulatory Level-1 probabilistic safety assessment (PSA) model (MPAS, multi purpose analysis safety) was developed to apply to risk informed regulation. To develop the MPAS model for Kori units 3, 4, various T/H analyses for using a best estimate analysis program and the HRA analysis using K-HRA methodology were performed for the success criteria determination. This MPAS model could be applied to develop the index for a graded regulation and to perform an independent risk analysis of Kori units 3, 4 in KINS (Korea Institute of Nuclear Safety).

ACKNOWLEDGEMENT

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