

The Preliminary Seismic Probabilistic Safety Assessment for HANARO Research Reactor



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Introduction

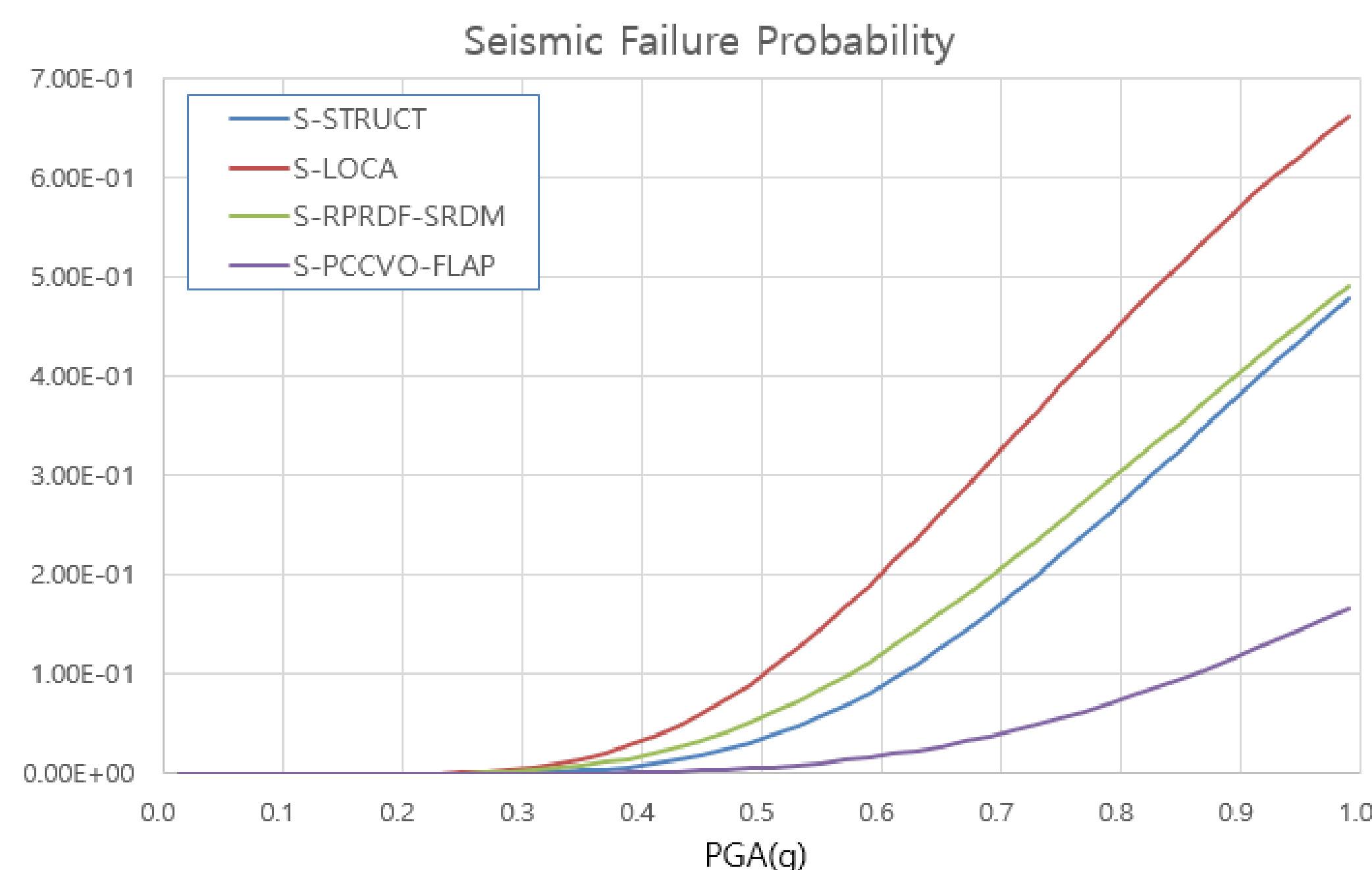
- ❖ According to the requirements of the Citizen Verification Team (2019.4 ~ 2018.3), a research project was launched in 2019
- ❖ The objective of the project is to prove that the operating research facilities are fully satisfied with the domestic nuclear safety goals (e.g., less than 0.1% of individual risks) through the risk profile assessment of the research site.
- ❖ This study focuses on, the preliminary level 1 seismic PSA for HANARO research reactor, which is one of the important contributor for research site risk assessment.

❖ The fragility curves of a SSC (Structure, System and Component) is defined as conditional failure probabilities for a given PGA level.

❖ The major SSCs analyzed in seismic events:

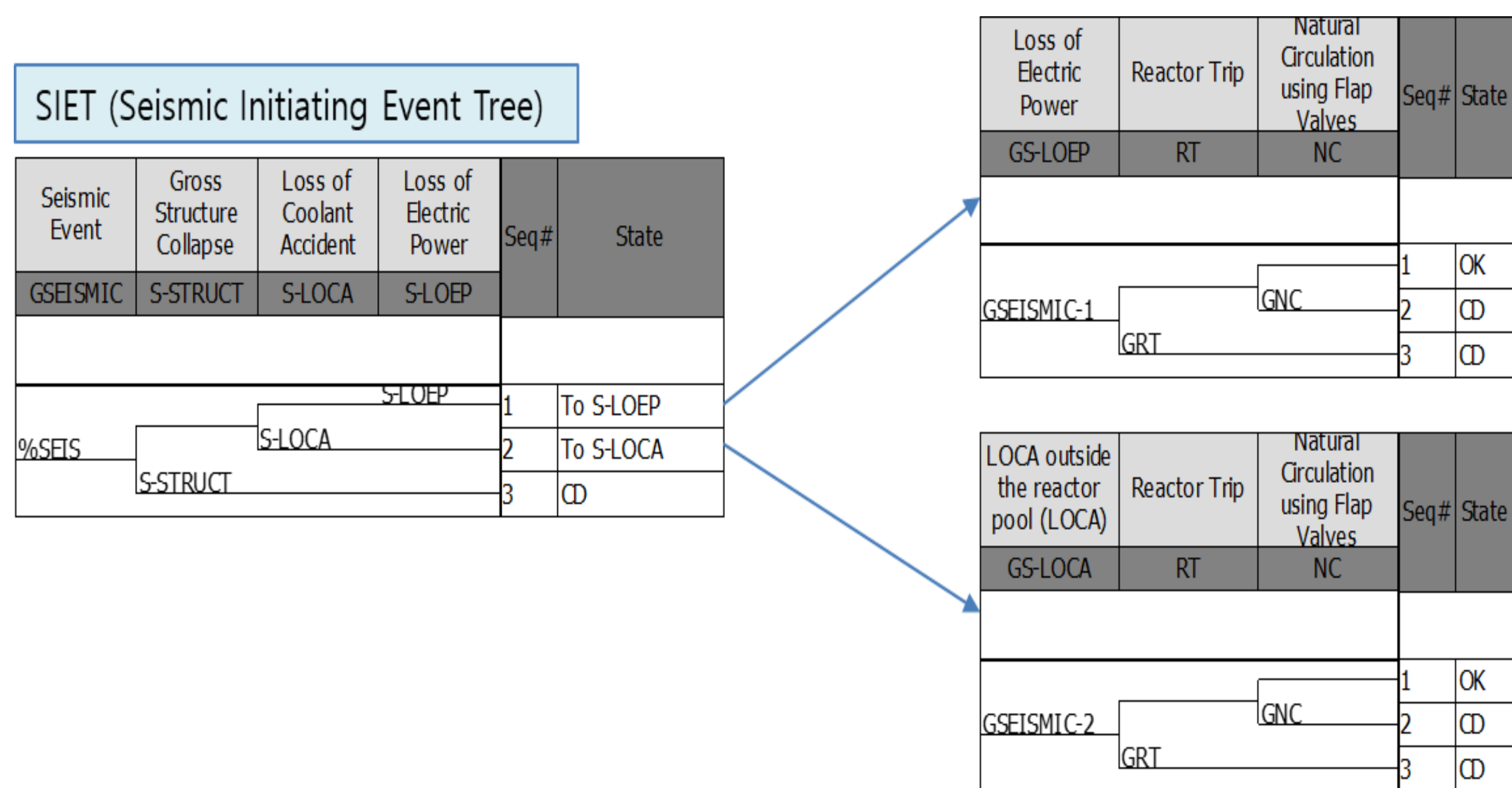
- Gross structure collapse (S-STRUCT)
- Loss of coolant accident (S-LOCA)
- Shutdown rod drive (S-RPRDF-SRDM)
- Flap valves 003/004 (S-PCCVO-FLAP)

❖ Seismic failure probability for SSC



Level 1 Seismic PSA Modeling

- ❖ Level 1 seismic PSA is performed that consists of:
 - Seismic hazard analysis
 - Seismic fragility analysis
 - Plant response analysis (event tree and fault tree analysis)
 - Core damage frequency (CDF) quantification.
- ❖ A seismic PSA model was constructed to describe scenario and component failure by earthquake, and CDF values were obtained for each bin.
- ❖ In this study, it is assumed that S-STRUCT (gross structure collapse) leads to core damage directly.
- ❖ scenario except S-LOCA (loss of coolant accident) is assumed S-LOEP (loss of electric power) conservatively.
- ❖ The Seismic event tree for HANARO



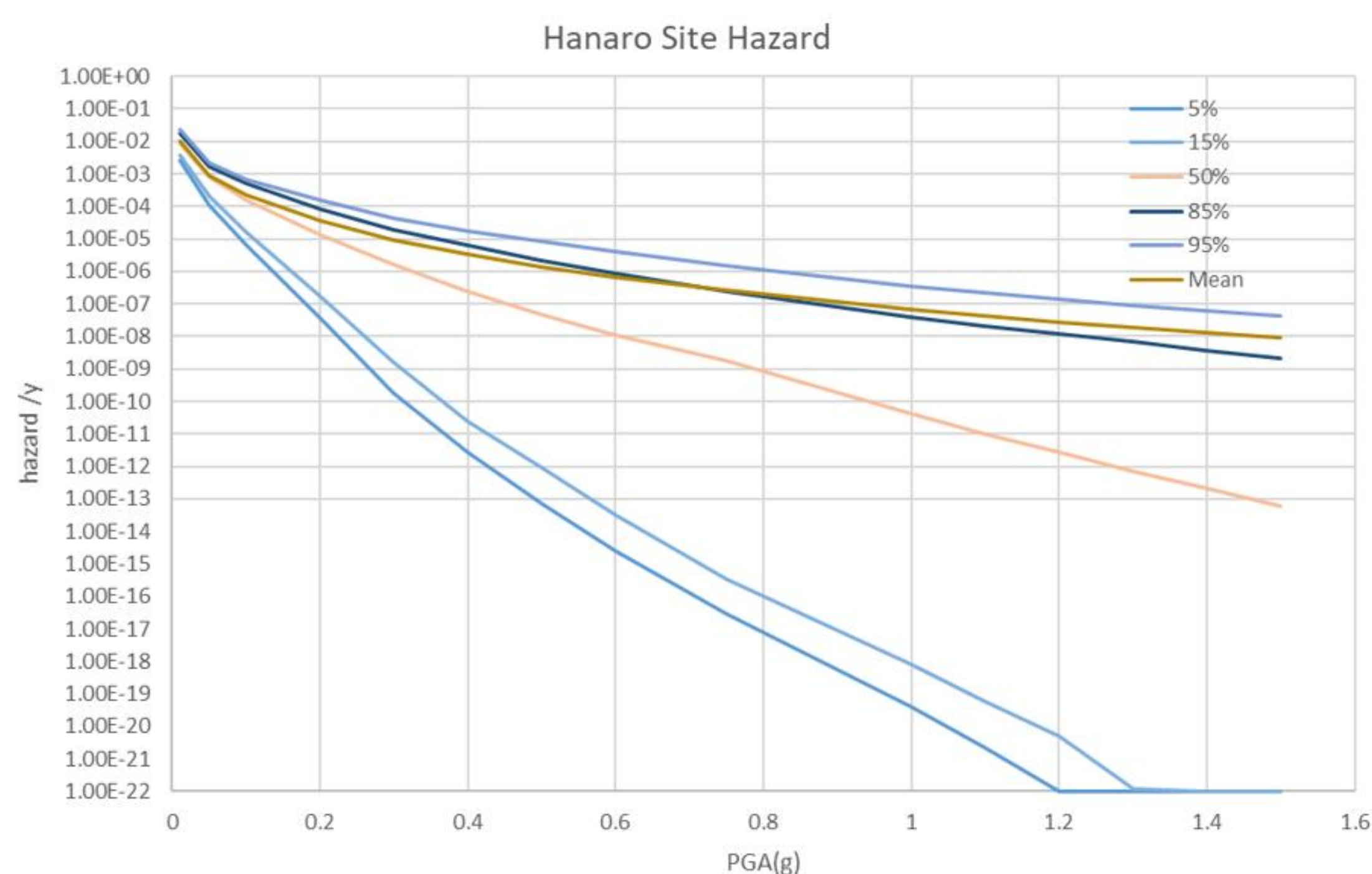
Preliminary Quantification Result

- ❖ Risk quantification using AIMS-PSA
- ❖ The cut-off value was set to 1E-22
- ❖ The preliminary quantification result.
 - S-LOEP and S-STRUCT are the major contributor for all bins.
 - S-LOEP is the scenario that LOEP is occur due to earthquake and major SSCs for accident mitigation is fail.
 - The S-STRUCT is the structural destruction scenario, which is a scenario in which reactor building is damaged by earthquake.
 - It is assumed that S-STRUCT leads do direct core damage conservatively.

scenario	Bin 1	Bin 2	Bin 3	Sum	%
S-STRUCT	5.406E-10	5.337E-08	2.423E-07	2.962E-07	41.82
S-LOEP	6.886E-09	1.253E-07	1.836E-07	3.159E-07	44.59
S-LOCA	2.790E-13	3.456E-09	9.277E-08	9.623E-08	13.59
Total	7.427E-09	1.822E-07	5.187E-07	7.083E-07	

Hazard Analysis and Fragility Analysis

- ❖ A seismic hazard curve presents the annual frequency (or rate) of exceedance for different values of a selected ground motion parameter (acceleration, velocity, etc.).
- ❖ HANARO seismic hazard curve



Conclusions

- ❖ The seismic level 1 PSA was performed on HANARO research reactor.
- ❖ The preliminary seismic PSA model was developed and evaluated using AIMS-PSA with conservative assumption.
- ❖ The preliminary quantification result (CDF result) was calculated as 7.083E-07/yr.
- ❖ S-LOEP, which is the loss of electric power due to earthquake, and S-STRUCT, which is the structural destruction scenario, accounts for the largest contributor among the scenarios.