

Adaptability Study of Hybrid ISA-PSA Method on Safety of Pyroprocess Facilities

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1. Introduction

KAERI is being developed pyroprocessing technology for spent fuel recycling. For this it is necessary to establish the facility development technology [1]. In this paper the Hybrid ISA-PSA method developed by US NRC was introduced and studied the adaptability on safety of pyroprocess facilities.

2. Safety study and Hybrid ISA-PSA method of US NRC

2.1 Safety Study of US NRC for SF recycling facilities

US NRC recommends and regulates fuel cycle facilities to follow ISA method through the code 10CFR70 [2, 3]. The main reason to use the ISA method is that the fuel cycle facilities have some chemical processes which are different from the nuclear reactors.

Recently US NRC is studying and suggesting the consequence thresholds and qualitative risk bins by risk indexing method for SF recycling facilities as following Table 1 and 2 [4-7].

Table 1. Consequence thresholds

	Workers	Offsite Public	Environment
Very High Consequence Event	RD>>1Sv CD>endanger life	RD>1Sv CD=endanger life	Radioactive release >500,000 x Table 2 of 10CFR20, Appendix B
High Consequence Event	RD>1Sv CD>endanger life	RD>0.25Sv sol U intake>30mg CD=long-lasting health effects	Radioactive release >50,000 x Table 2 of 10CFR20, Appendix B

Intermediate Consequence Event	RD>0.25Sv CD=long-lasting health effects	RD>0.05Sv CD=mild transient health effects	Radioactive release >5,000 x Table 2 of 10CFR20, Appendix B
Low Consequence Event	Accidents of lower radiological and chemical exposures than those above in this column	Accidents of lower radiological and chemical exposures than those above in this column	Radioactive releases producing lower effects than those referenced above in this column

Table 2. Qualitative risk bins

	Likelihood (Events Per Year)			
	Very Highly Unlikely (<1E-6)	Highly Unlikely (<1E-5)	Unlikely (<1E-4)	NOT Unlikely (>1E-4)
Consequence	VHCE	Acceptable	Not Acceptable	Not Acceptable
	HCE	Acceptable	Acceptable	Not Acceptable
	ICE	Acceptable	Acceptable	Not Acceptable
	LCE	Acceptable	Acceptable	Acceptable

US NRC is considering several methods for evaluation of SF recycling facilities including ISA and PSA, and suggests using the Hybrid ISA-PSA method for present time and the PSA method for the future [7].

2.2 Hybrid ISA-PSA method of US NRC [7]

The Hybrid ISA-PSA method, suggested by US NRC, processes according to the following steps. :

- Quantify all analyses to the extent practical and as supported by the state of the art.
- Use a quantified ISA to identify all credible accident sequences.
- Identify a subset of HCEs based upon attributes that significantly increase consequences above the high-

consequence thresholds, and designate this subset as VHCEs.

- Apply safety controls to render the likelihood of intermediate events, HCEs, and VHCEs acceptable.
- Conduct probabilistic risk analyses on HCEs and VHCEs to the extent practicable and consistent with the state of the art.
- Use the PRA results to aggregate risk from a subset of accident sequences for potential receptors.
- Adjust risk as needed to meet the appropriate NRC risk limits and criteria.
- Minimize the total risk to receptors beyond the minimum requirements.
- Identify GDC and/or other controls that reduce the risk beyond the minimum requirements as items supporting safety for accident situations.
- Require routine updates to the safety analyses, and establish a facility-specific program.
- Identify processes for ranking the various IROFS and events according to their risk importance.
- Identify processes for risk-informed safety review, inspection, and surveillance programs.

3. Adaptability of Hybrid ISA-PSA method to pyroprocess facilities

A PSA method needs a large data base including equipment reliability and test data, etc. For pyroprocess facilities, these data are too small when compared to other fuel cycle facilities. Pyroprocess facilities have some dry type process equipment and don't require large amounts of cooling water to prevent accidents. Although large amounts of radioactive fission products are stored and processed in hot cells, these fission products do not have large energy sources that could affect the integrity of hot cell walls. In this manner pyroprocess facilities are similar to wet recycling facilities described in [8]. PSA can give an insight to total risk of facility, but ISA can also be useful to determine the needed safety requirements for pyroprocess facilities. It can also give semi-quantitative risk values and a limited risk insight. The inspection processes for pyroprocess facilities can be risk informed by focusing resources on IROFS based on the ISA, which have similar properties to wet recycling facilities described in [8].

According to above considerations, it would be concluded that sole ISA, not Hybrid ISA-PSA, can

be a good method to evaluate the safety of pyroprocess facilities.

4. Conclusions

In this paper, the Hybrid ISA-PSA method, suggested by US NRC, for safety evaluation of SF recycling facilities was introduced and studied the adaptability to pyroprocess facilities. According to this study, it is concluded that sole ISA, not Hybrid ISA-PSA, can be a good method to evaluate safety of pyroprocess facilities.

Acknowledgements

This study was supported by the Ministry of Science, ICT and Future Planning through its National Nuclear Technology Program.

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