

Benefits of the ISA Application to Pyroprocessing Facilities

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1. Introduction

KAERI has been developing pyroprocessing technology for a safe and an effective disposal of spent fuel. For verification of this technology, it is necessary to develop the experimental facility with hot cells and auxiliary systems in the future [1]. In this paper, safety analysis methodologies for fuel cycle facilities in the United States and Korea are introduced, and benefits of the application of the ISA (Integrated Safety Analysis, US NRC) to pyroprocessing facilities are studied.

2. Present and Future of the ISA

NUREG-1520 is a guidance of US NRC for reviewing and evaluating the health, safety, and environmental protection aspects of applications for fuel cycle facility licenses. This guidance addresses the longstanding health, safety, and environmental-protection requirements of 10 CFR Part 20 and 10 CFR Part 70, as well as the accident safety requirements reflected in Subpart H, “Additional requirements for certain licensees authorized to possess a critical mass of special nuclear material,” of 10 CFR Part 70. Subpart H of 10 CFR Part 70 identifies risk-informed performance requirements and requires applicants and existing licensees to conduct an Integrated Safety Analysis (ISA) [2].

The ISA is a systematic, risk-informed and performance-based analysis. The NRC considers an ISA method required by 10 CFR Part 70 to be appropriate to address the types of hazards and accident sequences associated with existing fuel cycle facilities.

However, the presence and processing of large quantities of fission products and TRU isotopes at spent fuel processing facilities have the potential to greatly increase consequences far above the 10 CFR

Part 70 high-consequence thresholds for some accident sequences (e.g., fires, explosions), and, therefore, 10 CFR Part 70 is not appropriate for spent fuel processing facilities. The NRC concludes approaches that incorporate more quantitative risk assessment, including PRA, are needed to adequately address safety and risk at spent fuel processing facilities. Recently the NRC is considering two basic approaches—a hybrid ISA-PRA approach and a PRA approach. The NRC considers the hybrid approach is a reasonable starting point at this preliminary stage of the NRC’s efforts in support of potential future rulemaking activities [3-7].

3. Present Korean Safety Regulations for Pyroprocessing Facilities

The Korean Nuclear Safety Act requires applicants to conduct a standard safety analysis methodology similar to that of nuclear power reactor, such as deterministic and defense-in-depth safety methodologies. The Paragraph (3) of Korean Nuclear Safety Act article 35 requires that a person, who intends to carry on the spent fuel processing business, shall submit to the competent minister an application for the permit or the designation together with radiation environmental report, safety control regulations, explanatory statement of design and work methods, quality assurance program for the operation of the business and other documents as prescribed by the Ordinance of the Prime Minister [8].

In Korea the pyroprocessing facilities are regulated as one of fuel cycle facilities under the Korean Nuclear Safety Act. The act describes the safety requirements for the license and operation of fuel cycle facilities. Although the safety requirements for fuel cycle facilities show small differences compared to those of nuclear power plants, but a large parts of the requirements use the same technical criteria with nuclear power plants.

4. Benefits of the ISA Application to Pyroprocessing Facilities

Pyroprocessing is inherently a batch process which means that materials must be moved as solid physical objects among most of the various steps. The size of the batches is limited by criticality considerations. The maximum throughput of a single electrorefiner is about 50 MTIHM/yr. On this basis, a pyroprocessing plant would require the operation of 16 electrorefiners in parallel to achieve the 800 MTIHM/yr throughput of the French UP3 aqueous spent fuel processing facility. The large number of movements of highly radioactive objects containing fissile materials in this manner is likely to require high equipment reliability, low accident likelihood, and a greater need for nuclear material accountability [9].

The ISA is a systematic, risk-informed and performance-based analysis. The ISA provides the framework and establishes the needed safety basis to assure that the handling of nuclear material is within the programmatic requirements, that the safety program is appropriate for the risk, and that the measures for carrying out the safety program are appropriately monitored.

For development of safer pyroprocessing facilities safety analysis is needed through a better safety analysis methodology that can reflect the properties of pyroprocessing. Applying the ISA to pyroprocessing facilities would benefit for developing a safer and more reliable facility.

5. Conclusions

For development of safer pyroprocessing facilities it is necessary to evaluate the safety through a better analysis methodology that can reflect the properties of pyroprocessing. The ISA is a systematic, risk-informed and performance-based analysis methodology for fuel cycle facilities. Applying the ISA to pyroprocessing facilities would benefit for developing a safer and more reliable facility.

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