

# Safety Design Criteria for Spent Nuclear Fuel Cycle Facility

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## 1. Introduction

As part of its international efforts to promote the recycling of Spent Nuclear Fuel for use of sustainable nuclear energy, the development and demonstration of Sodium-cooled Fast Reactor, and the increase of non-proliferation, KAERI conducted the preliminary concept design of the Korea Advanced Pyroprocessing Facility (KAPF) based on the design requirements and criteria.

As mentioned in the preliminary plan ('14), KAERI carried out a preliminary feasibility study on pyroprocessing that can review safety and safeguards to help license for large-scale pilot plants. However, the regulations and regulation guides that can be referenced in Korea are mostly applicable only to nuclear power plants among nuclear facilities, which is difficult to apply directly to KAPF. Therefore, KAERI are studying Integrated Safety Analysis (ISA) for nuclear fuel cycle facility using US-NRC regulation guidance and SECY reports. An ISA identifies potential accident sequences in the facility's operations and designates items relied on for safety (IROFS) to either prevent such accidents or mitigate their consequences to an acceptable level.

In this paper, the safety classification of nuclear power plants is analyzed and the applicability of Codes&Standards for the safety design of nuclear fuel cycle facilities such as KAPF is evaluated based on the analysis study as mentioned above in order to compensate the gap of domestic regulations and regulation guides

## 2. Safety Classification

### 2.1 Status of Safety Classification for Nuclear Power Plants

In Korea, the safety classification of the nuclear facilities, including the nuclear fuel cycle facilities and nuclear power plants, are established based on

the Announcements of Nuclear Safety and Security Commission and KEPIC Standards. Because the background of such a safety classification eventually begins with safety analysis of the nuclear power plants, the requirements and technical standards applicable to only nuclear power plants are proposed. In particular, the Codes&Standards referred to in ANSI/ANS-51.1 say that the design of a nuclear power plants requires the integration of a number of interdisciplinary considerations to ensure that nuclear safety criteria are adequately identified and implemented.

### 2.2 Status of Safety Classification for Nuclear Fuel Cycle Facilities

Domestic regulations on the nuclear fuel cycle facilities provide legal requirements such as permission, inspection, decommission and declaration in the Nuclear Safety Act Chapter 4 (Nuclear Fuel Cycle Business and Use, Etc. of Nuclear Materials). In addition, it refers to common regulatory oversight, supplementary provisions, and penalties as the nuclear facilities as well as the nuclear power plants.

More details on the nuclear fuel cycle facilities are mentioned in the enforcement rule of Nuclear Safety and Security Commission (Regulations on Technical Standards for Nuclear Reactor Facilities, Etc.). Chapter 3 of this enforcement rule provides comprehensive technical standards such as location, Structure, Installations, Performance, Operation, Quality Assurance, and Disassembly of the nuclear fuel cycle facilities. However, compared with the contents of Chapter 2 of this enforcement rule that provides for the nuclear reactors, so only Article 93 say that the material and structure of the vessels, pipes, pumps and valves that are utilized at the nuclear fuel cycle facilities and major supporting structures thereof shall meet the technical standards by the safety classes and standards. Even in Article

93, there is no guidance on detailed classification criteria or applicable items.

### 2.3 Limitation of safety classification of the nuclear fuel cycle facilities

As mentioned previously, relatively many discussions and developments in the nuclear power plants have resulted in a consistent framework, but very poor conditions at the nuclear fuel cycle facilities. The notice referred to in Article 93 of the Enforcement Rule of the Nuclear Safety and Security Commission, the only guidance for safety classification of the nuclear fuel cycle facilities, is based on ANSI/ANS-51.1-1983. This Codes&Standards only apply to the nuclear power plants. Nevertheless, Article 98 of the Enforcement Rule of the Nuclear Safety and Security Commission states that certain standards may not apply in those cases where it is acknowledged by the Nuclear Safety and Security Commission that such standards are not directly applicable to the nuclear fuel cycle facilities as the purpose of the facilities is for research/experiment or due to the facility and technical characteristics thereof, or that safety is not affected even if such standards are not applied. Therefore, for KAPF and other research facilities, there is a possibility to apply regulations that are similar to general industrial facilities.

### 3. Safety Design Criteria for KAPF

In this paper, safety classification was conducted by Integrated Safety Analysis (ISA). An ISA identifies potential accident sequences in the facility's operations and designates IROFS to either prevent such accidents or mitigate their consequences to an acceptable level.

#### 3.1 Consequence categorization

Based on the KAPF preliminary feasibility study for facility safety results and ANSI/ANS-58.16-2014, a consequence classification was proposed as below:

KAPF ISA	ANSI/ANS-58.16-2014 safety categories
Very High Consequence	Hazard SC-3
High Consequence	Hazard SC-2
Intermediate Consequence	Hazard SC-1
Low Consequence	

### 3.2 Safety Design Criteria for KAPF

In this paper, Codes&Standards for SSC applicable to design basis accidents corresponding to SC-2, SC-3 are summarized as follows, referring to ANSI/ANS-58.16-2014 and DOE O 420.1C. However, if there is a separate Codes&Standards for the nuclear fuel cycle facilities, such as the nuclear power plants (ANSI/ANS-58.14), it should be prioritized.

Design Criteria	Classification	Standard number	Title
General Design Criteria	Single-failure criterion	IEEE STD 379-2014	IEEE Standard for Application of the Single-Failure Criterion to Nuclear Power Generating Station Safety Systems
		ANSI/ANS-58.9-2002 (R2015)	Single Failure Criteria for Light Water Reactor Safety-Related Fluid Systems
	Quality Assurance	10 CFR Part 830, Subpart A	Quality Assurance Requirements
		DOE O 414.1D	Quality Assurance

### 4. Conclusion

In this paper, safety design criteria were established for designing large-scale spent fuel processing facilities such as KAPF, and design, manufacture, construction, maintenance, and quality control of safety-critical structures, systems and components derived from ISA.

As already mentioned above, a consistent Codes&Standards or design was possible to apply for nuclear power plants since most structures are similar to those of the existing and new ones. However, there are no consistent regulations, guidelines, or Codes&Standards for the nuclear fuel cycle facilities, including large-scale spent fuel processing facilities with similar histories. It is true that the common regulatory or guidelines cannot be applied compared to the nuclear power plants because the nuclear fuel cycle facility is variable depending on the purpose and situation of them.

This paper attempts to establish a framework of Codes&Standards applicable to the spent nuclear processing facilities such as KAPF based on the results of preliminary safety analysis with KAPF preliminary concept design. Therefore, in order to design and construct such nuclear fuel cycle facilities at this time, use all of the Codes&Standards and guidelines that may be referenced by the licensee (designer, developer) prepare the licensing steps.