Safety Classification and Applicable Codes and Standards for Structures, Systems and Components (SSCs) in Nuclear Fuel Cycle Facilities (NFCs)

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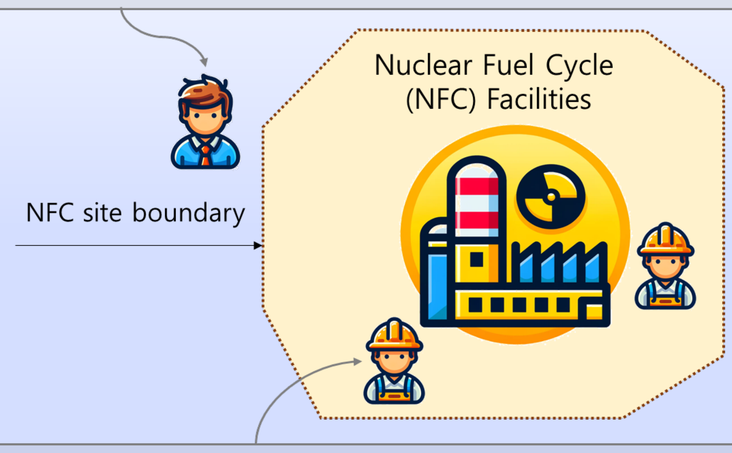
Abstract

- The safety classification system for nuclear fuel cycle facilities (NFCs) in domestic regulatory systems is inadequate because that of reactors is used.
- Accordingly, this paper reviews the safety classification system of Structures, Systems, and Components (SSCs) for NFCs based on regulatory documents in the US and we examined the differences in codes and standards applicable to safety classification categories.
- In Korea, similar to the US, it is necessary to establish a separate safety classification system for NFCs, rather than conservatively adhering to the reactor safety classification system. Additionally, the development of the set of codes and standards commensurate with the separate safety classification system should be carried out concurrently.

Safety Classification and Designation of Safety Controls for NFCs

- US DOE-3009 and NRC NUREG-1520 in the US are used as guidelines for the preparation and review of safety analysis reports for NFCs to confirm their safety. In particular, DOE clearly distinguishes safety categories as Safety Class (SC) and Safety Significant (SS).
- The SC controls are designated to prevent and mitigate consequences that may have a serious impact on offsite public, with a criterion of 250 mSv for Maximally exposed Offsite Individual (MOI), which is the same basis as in South Korea.
- However, since such accidents are extremely unlikely to occur outside of non-reactor facilities, it is not typical to designate SC controls for nuclear fuel cycle facilities with lower hazard.
- Instead, DOE designates SS controls for accidents that may cause significant consequences to co-located and facility workers. The specific purposes of introducing SS controls are as follows: (1) defense-in-depth; (2) protection of the public from release of hazardous chemicals; (3) protection of co-located workers from hazardous chemicals and radioactive materials; and (4) protection of in-facility workers from fatality, serious injury, or significant radiological or chemical exposure.

The US & S. Korea both have the same criteria* for public dose
** Less than 250 mSv to whole body for MOI (Maximally exposed Offsite Individuals)*
To meet the criteria, **Safety Class (SC)** Controls are required as means of prevention and mitigation of accidents.



The US has the criteria* for worker dose but S. Korea does not.
** Less than 1 Sv to whole body for collocated and facility workers*
To meet the criteria **Safety Significant (SS)** Controls are required as means of prevention and mitigation of accidents.

〈Dose criteria and the rule of designation of Safety Class (SC) and Safety Significant (SS) controls〉

Applicable Codes and Standards According to Safety Classification (US)

- It can be noted that the codes and standards for designing, installing and testing SSCs designated as SS controls differ from those for SSCs designated as SC controls, particularly, in the fields of “structural”, “electrical and instrumentation, Control, and Alarm Components.”
- The codes and standards for concrete structures, ACI-318 is a regulation for general concrete structures, while ANSI/ACI 349 is tailored for special structures such as nuclear power plants that require heightened safety measures.
- The design of SC instrumentation and control systems must incorporate sufficient independence, redundancy, diversity, and separation to ensure that all safety-related functions associated with such equipment can be performed. SS components must be evaluated as to the need for redundancy on a case-by-case basis. DOE-STD-1195-2011 provides an acceptable method for achieving high reliability of SS safety instrumented systems.
- However, the codes and standards that SC and SS controls must meet for the fields of “mechanical and process equipment”, “ventilation”, “mechanical handling equipment” are the same.

Table I. Codes for Safety-Significant and Safety-Class Structures

Structures	Safety-Significant	Safety-Class
Concrete	*ACI-318*	ANSI/ACI-349
Steel	*AISC-360; AISC-325*	AISC-N690

Table II. Codes for Safety-Significant and Safety-Class Electrical Systems

Electrical	Safety-Significant	Safety-Class
Hardware	Applicable NFPA codes and standards; IES Lighting Handbook; ANSI C2; IEEE C37; IEEE-80, -141, -142, -242, -399, ***-446*** -493, -577	Applicable NFPA codes and standards; IES Lighting Handbook; ANSI C2; IEEE C37; IEEE-80, -141, -142, -242, -308, -338, -379, -384, -399, -493, -577

Table III. Codes for Safety-Significant and Safety-Class Instrumentation, Control, and Alarm Components

Instruments, Controls, and Alarms	Safety-Significant	Safety-Class
Hardware	Applicable NFPA codes and standards; ANSI C2; ANSI/ANS-8.3, -58.8, -59.3, -N13.1, ANSI-N323D; ANSI/ISA-Series including ISA 67.04.01 and ISA TR 84.00.06; IEEE-N42.18, –1023, -1050, -7-4.3.2; *and **DOE-STD-1195-2011** (implements ISA 84.00.01)*	Applicable NFPA codes and standards; ANSI C2; ANSI/ANS-8.3, -58.8, -59.3, -N13.1, ANSI-N323D; ANSI/ISA-Series including ISA 67.04.01 and ISA TR 84.00.06; IEEE-N42.18; -1023, -1050, -7-4.3.2

Discussion and Conclusions

- Safety classification for domestic NFCs in Korea is not distinguished from that of reactors, so it is difficult to apply graded approach to requirements for the manufacturing, installation, and testing SSCs of NFCs. Applying technological standards that are based on reactors to NFCs is highly conservative and results in inefficiency. In contrast, the US DOE has a typical safety classification system for NFCs with lower potential hazard compared to reactors.
- The introduction of a new safety classification system requires extensive discussion, especially if new safety class category such as SS is to be introduced. In such cases, the codes and standards applicable to this safety class category should also be discussed concurrently since domestic regulatory system has well-established technical standards for SC but there has been no discussion regarding other safety class categories.