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

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***Keywords :** safety classification, safety class, safety significant, codes and standards, nuclear fuel cycle facility

1. Introduction

The safety classification system for nuclear fuel cycle facilities (NFCs) in domestic regulatory systems is inadequate compared to that of reactors [1]. Accordingly, this paper reviews the safety classification system of Structures, Systems, and Components (SSCs) for NFCs based on regulatory documents [2, 3] in the US. Additionally, it examines the differences in codes and standards applicable to safety classification categories.

2. Safety Classification and Designation of Safety Controls for NFCs

US DOE-3009 [2] and NRC NUREG-1520 [4] 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 [5]. However, since such accidents are 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.

3. Safety Classification for SSCs in the US DOE

Although the SC controls required for reactors are not necessary for NFCs, it is evident that the designation of SS controls is necessary from the aspects of defense-in-depth and worker protections. 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 [2].

3.1 Structural

Table I provides relevant codes and standards. It shows codes and standards for SS and SC structures are perfectly different.

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

3.2 Electrical

Tables II provides codes and standards for SS and SC electrical systems.

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

3.3 Instrumentation, Control, and Alarm Systems

The design of safety-class 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. Safety-significant 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 safety-significant safety instrumented systems. Table III provides relevant codes and standards.

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, -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

3.4 Other SSCs

Based on DOE O 420.1c, other SSCs including Mechanical and Process Equipment, and Ventilation, Mechanical Handling Equipment have the same codes and standards for both SC and SS controls.

4. Discussion

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.

5. Conclusions

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.

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