A Study on the Safety Class Designation of the Hot Cell Facility

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1. Introduction

As the decommissioning of domestic nuclear power plants(NPPs) has become more serious, the construction of the hot cell facility(HCF) is being promoted which will support the characterization of the low and intermediate level waste generated from the NPP decommissioning activities. Therefore, to design the HCF, the guideline on the safety classification of structures, systems, and equipment (SSCs) is developed for safety control of the HCF. Even though there are guidelines on classification of safety class of nuclear reactor facility in Korea, there are no guideline for non-reactor facility such as the HCF. Therefore, this paper provides the domestic guideline to classify the safety class for the HCF through the review of the regulatory to the non-reactor facilities in U.S. DOE and NRC.

2. Status of domestic guidelines on the classification

The safety classification scheme on the structures, systems, and components (SSCs) in the NPPs is controlled by Nuclear Safety and Security Commission(NSSC) Notice No. 2017-21 (Regulations on the safety class and other classes of the NPP). In the Article 3(4) in the Notice, the term of "safety function" means the function of securing the integrity of the pressure boundary of the reactor coolant at the nuclear power plant, maintaining the safe shutdown and shutdown status of the reactor, and preventing or mitigating situations that may exceed the offsite exposure limit prescribed by the NSSC.

NSSC Notice No. 2017-15 "Guidance on the Location Restriction of Nuclear Facilities" stipulates that 10 CFR 100.11 "Detection of Exclusion Area, Low Population Zone and Population Center Distance" shall be mutatis mutandis. It is classified into safety or non-safety class depending on whether the whole-body dose of the public exceeds 0.25 Sv (25 rem) and thyroid dose 3 Sv (300 rem) in the accident conditions of the NPP. Therefore, according to this regulation, it is possible to determine whether the safety class or non-safety class is defined through the accident analysis of the NPP. If the NPP related regulations are applied to the design of the HCF, the safety class can be determined through the accident analysis with reference to the above by referring to the NSSC Notice No. 2017-15 and the NSSC Notice No. 2017-21[1, 2].

3. Status of overseas guidelines on the classification of the HCF

In the United States, 10 CFR 830 is applied to design the storage and disposal of other nuclear facilities and radioactive materials, and ANSI/ANS-58.16 is referred to. In ANSI/ANS-58.16 three safety categories (SC-1, SC-2, and SC-3) are classified in consideration of the radiation effects of design basis events(DBEs) on the population. Compared with the safety class guidelines applied by DOE, NRC, and domestic NPPs, this is as shown in Table 1[3,4].

Table 1. Relationship of safety class designated by ANSI/AN S-58.16, DOE, NRC and Korean Notice.

ANSI/ANS -58.16	**DOE SC** [5,6]	**NRC (10CFR50)**	**Korean NPP**
Safety Categories 3 (Exposure dose > 0.25 Sv)	Safety Class (Hazard category1)	Seismic Class [7]	Nuclear Safety Class 3
Safety Categories 2 (0.05 Sv < Exposure dose < 0.25 Sv)	Safety Significant (Hazard Category2)	Safety Class [8] RW-IIa	Non Nuclear Safety Class
Safety Categories 1 (Radiation exposure is lower than SC-2, but higher than normal operation regulations)	Important to safety (Hazard Category3)	Safety Class RW-IIb	

10 CFR 830, Subpart B stipulates that hazard categories are classified and that facilities are designed and operated accordingly. In order to categorize a hazard category, it is assumed that mitigation equipment is not operating as a result of any hazard. Based on the unmitigated release of radioactive materials, the hazard categories of non-reactor nuclear facilities should be categorized as follows[4].

- Hazard category 1: Hazard Analysis shows the potential for significant off-site consequence.
- Hazard category 2: Hazard Analysis shows the potential for significant on-site consequences.
- Hazard category 3: Hazard Analysis shows the potential for only significant localized consequences .

The accuracy of accident analysis input values increases as the design phase progresses with DOE-STD-1027-92 for criteria for selecting hazard categories for non- reactor nuclear facilities. The method of graded approach is presented, and in the conceptual design phase, the standard value of table 2 is presented to determine the hazard category based on the amount of radioactive material inventory handled in the HCF [9].

Table 2 Threshold maximum inventory by major nuclide according to the hazard category

Isotope	Category 2 Curies	Threshold Grams	Category 3 Curies	Threshold Grams
H-3	3.0E+05	3.0E+01	1.6E+04*	1.6E+00*
C-14	1.4E+06	3.1E+05	4.2E+02	9.4E+01
Co-60	1.9E+05	1.7E+02	2.8E+02	2.5E-01
Ni-63	4.5E+06	8.0E+04	5.4E+03	9.5E+01
Sr-90	2.2E+04	1.6E+02	1.6E+01	1.2E-01
Nb-94	8.6E+04	4.6E+05	2.0E+02	1.1E+03
Tc-99	3.8E+06	2.3E+08	1.7E+03	1.0E+05
Xe-133	1.8E+06	9.6E+00	2.0E+04	1.1E-01
Cs-137	8.9E+04	1.0E+03	6.0E+01	6.9E-01

4. Direction of safety class setting

Since the domestic HCFs will handle low- and intermediate-level waste generated from the NPP decommissioning, it can be seen that it corresponds to Hazard Category 2 and Hazard Category 3 in accordance with criteria of Table 2.

5 . Conclusions

It is noted that the most Hot Cells operating in the United States are classified as Hazard Category 2 in maximum, and the HCF is below the 10 CFR 100.11 requirement above as results of preliminary accident analysis. Considering also the characteristics of intermediate-level radioactive waste to be handled by the HCF, it is deemed appropriate to classify the structure, system, and components (SSCs) of the HCF into non-safety class. (This is something to be verified in a detailed accident analysis in the future.) However, if the function of treating, extracting, packing, or storing radioactive waste is performed pursuant to Article 8 (2) 1 of the Nuclear Safety And Security Commission Notice 2017-21, it seems appropriate to strictly manage quality class (class A) and seismic category (class II) for structures, systems and devices corresponding to ANSI/ANS 51.1-1988.

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REFERENCES

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