Method to classify the safety class of Structure, System and Components in a Defueled Condition of Nuclear Power Plant

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1. Introduction

For Kori #1 nuclear power plant (NPP), a permanent shutdown is determined. A decommissioning for Kori #1 NPP should be prepared. Typical decommissioning sequences are pre-decommissioning (transition) phase, phase for removing fuel from the storage, phase for highly contaminated systems removal, phase for remaining systems being removed, phase for buildings being decontaminated and phase for final remediation and site release. During pre-decommissioning phase, licensing and engineering work need to change the design basis of the plant such as safety analysis report, downgrade of systems, technical specifications and program and procedures to change of NPP condition from in an operation condition to in a defueled condition.

The many systems to need to operate in an operational condition will not be operated during in a defueled condition and the function of systems will be changed from in an operation condition to in a defueled condition. So a downgrade of systems may be needed and reclassifying the safety class of structure, system and component (SSC) may be conducted. By the reclassification of SSC, activity related with quality assurance and maintenance of SSC is affected. In this paper, the method to reclassify SSC in a defueled condition is studied.

2. Reclassification of SSC

2.1 Safety class during operation

In 10 CFR 50.2[1] the safety-related SSC is defined SSC that are relied upon to remain functional during the following design basis events to assure the integrity of the reactor coolant pressure boundary, the capability to achieve and maintain safe shutdown, and the capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to applicable guideline exposures such as 10 CFR 50.34(a)(1) or 10 CFR 100.11. [2]

Nuclear Safety and Security Commission Notice 2016-15[3] is describing the regulation on safety class and its standard of reactor facility which states classification of SSC as safety class 1, safety class 2, safety class 3 and non-safety class. Classification of SSC in a defueled condition should be satisfied with the regulation for that in an operational condition

2.2 Safety class during a defueled condition

In a defueled condition, the first two functions among the safety function defined as 10CFR50.2 are not applicable. The accidents for a defueled condition shall be evaluated that the consequences of accidents could result in potential offsite exposures. SSC to prevent or mitigate consequences of accidents to fulfill the safety functions should be classified as safety-related SSC.

For the Zion NPP[4], there are no SSC which is required to be classified as safety-related SSC defined in 10CFR50.2 in a defueled condition so SSCs which have the functions to support a fuel safety or radiation protection safety are designated as important to the defueled condition (ITDC). There are four criteria to determine which SSCs are designated as ITDC as following:

Criteria 1. Is the SSC associated with storage, control, or maintenance of nuclear fuel in a safe condition; or handling of radioactive waste? This includes direct as well as indirect effects.

Criteria 2. Is the SSC associated with Radiological Safety?

Criteria 3. Is the SSC associated with an outstanding commitment to the regulators which remains applicable to storage, control, or maintenance of nuclear fuel in a safe condition; or handling of radioactive waste?

Criteria 4. Does the SSC satisfy a requirement based in regulations? This includes any SSC which is independently required by Technical Specifications.

A positive response to any criteria identifies ITDC. A negative response to all criteria indicates that an SSC is a non-ITDC SSC.

Nuclear Safety and Security Commission Notice 2016-15 is describing the regulation on safety class and its standard of reactor facility which states classification of SSC as safety class 1, safety class 2, safety class 3 and non-safety class. Safety functions for safety class 3 include radiological shielding to protect people in main control room and offsite and cooling of wet storage spent fuel and supporting system for safety class 1, 2 or 3. There are safety class 3 SSCs under the defueled condition according to Korea domestic act. If the Korean domestic act should be applied to classify the safety class of SSC, the same classification of SSC can be used. The safety functions defined as Korea domestic act considered in a defueled condition are

similar with the safety functions of SSC designated as ITDC.

2.3 Method to reclassify safety class

SSCs are designated as safety-related and non-safety-related during the normal operation. During a defueled condition, some SSCs such as the reactor coolant system and related system are not operated and the functions of SSCs are changed. For a defueled condition, SSCs can be classified as safety-related or ITDC, operational and irrelevant as shown Figure 1. If SSCs are not operated, the SSCs are classified as irrelevant. For a defueled condition, the operating SSC are classified as safety related or operational.

To determine the safety class of SSC, it is determined that an SSC is or is not safety related. The first step to classify SSC is to determine the safety objectives for a defueled condition. The possible safety objectives are control of reactivity, cooling of fuel assembly, confinement of radioactive material and limitation of radiation exposure.

The second step is to determine the revised accident analyses related with the safety objectives. Examples of representative events are earthquake including consequential failures, loss of off-site power (> 10 hours), failure of spent fuel pool cooling, loss of spent fuel pool water, fuel handling accidents, internal flooding of the reactor building annulus, internal fires, and external events (airplane crash, explosion…) under a defueled condition.

The system functions to fulfill the safety objectives are fulfilled through the safety systems. SSCs consisting the safety systems and fulfilling the safety functions are designated as safety-related or ITDC. Table I shows the example of the reclassification of SSCs.

The results of revised accident analyses are time dependent because the status of spent fuel such as the decay heat and the activity inventory are time-dependent. So, the classification of SSCs may be different from the time definition for a defueled condition.

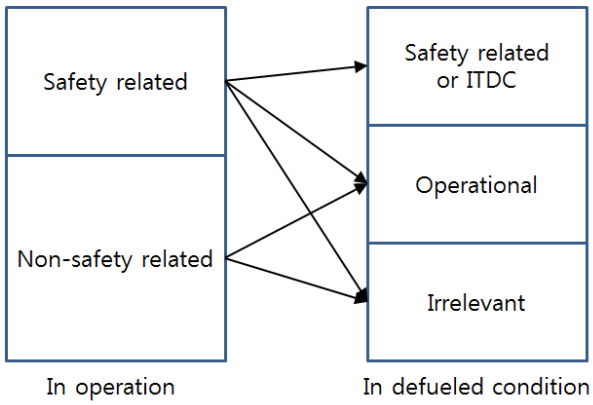

Fig. 1. Reclassification of SSC in a defueled condition

Table I: Example of Reclassification

	safety-related	non-safety-related
safety-related or ITDC	the spent fuel pool cooling system	
operational	emergency core cooling system	demineralized water supply system
Irrelevant	steam generator feed water system	generator

The supporting system for the spent fuel pool cooling and cleaning system may have the multi-purpose function. For example, component cooling water system (CCW) supports not only the spent fuel pool cooling and cleaning system but also other component such as the reactor coolant pump seal cooling and the other heat exchanger. Therefore some SSCs of CCW are classified as the safety-related or ITDC and others are classified as the operational or irrelevant.

4. Conclusions

The many systems to need to operate in an operational condition will not be operated during in a defueled condition and the function of systems will be changed from in an operation condition to in a defueled condition. The operation of NPP during a defueled condition need to conduct licensing and engineering work need to change the design basis of the plant optimize by downgrading systems and reclassifying the safety class of SSC. In this paper, the method to reclassify safety class for a defueled condition is studied. Safety class of SSC during a normal operation is reviewed. Case studies of reclassification for safety class of SSC for a defueled condition are reviewed.

REFERENCES

[1] U.S. Nuclear Regulatory Commission, Title 10, Code of Federal Regulations Part 50 Domestic Licensing of Production and Utilization Facilities.
[2] U.S. Nuclear Regulatory Commission, Title 10, Code of Federal Regulations Part 100 Reactor Site Criteria.
[3] Notice of Nuclear Safety and Security Commission No. 2016-15, Regulation on Safety Classification and Applicable Codes and Standards for Nuclear Reactor Facilities.
[4] Zion Station Defueled Safety Analysis Report, 1998.