Development of Emergency Plan for Permanently Defueled Condition of Kori Unit 1

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1. Introduction

Kori Unit 1, the first PWR (Pressurized Water Reactor) plant in Korea, will permanently shut down in June, 2017 for decommissioning. Along with the other operating license document, Emergency Plan also should be revised for the permanently defueled condition. After ceasing the plant operation, various systems are isolated and the spent fuels are stored in SFP (Spent Fuel Pool). Therefore, Radiation Emergency Plan for permanently defueled condition (PDEP) should reflect those changed plant conditions and be revised for effective radiation preparedness. This paper will describe the development concept and draft result of PDEP for Kori Unit 1.

2. Main Discussion

2.1 Overview

Plant operation licensee of Kori Unit 1 will be revised for permanently defueled condition, and the plant's Final Safety Analysis Report (FSAR) needs to be updated as DSAR(Defueled Safety Analysis Report).

DSAR involves revision of SSC (System, Structure, Component), source terms, and accident analyses as is reflects the lowered radiological source term and risks associated with spent fuel pool storage relative to reactor at-power operation.

Basically, Kori Unit 1 PDEP development is focused on the consistency with DSAR. Additionally, associated guidance and cases of U.S. were reviewed for further considerations.

2.2 Consideration of consistency with DSAR

The plant structures, components, and systems have been reclassified in DSAR according to their functions and the degree of integrity required to protect the public and to maintain the plant safety. This includes elimination of the need for various ECCS systems to mitigate reactor or containment accidents. After a reactor is permanently defueled, the accidents that dominate plant risk during power operation are no longer applicable.

To reflect those changes effectively, EALs (Emergency Action Levels) for operating power plant were reviewed based on the reclassification of SSC and other revisions in DSAR, which shown in Table 1.

Table 1. EAL Related DSAR Analysis

DSAR Section	EAL Related Terms in DSAR
3.2	Reclassification of SSC and Quality Assurance Categories for Permanently Defueled Condition
6.2, 6.4	Fire Impact Analysis : Containment Systems, Habitability Systems
8	Electric Power Effectiveness(On/Off-Site Power System)
11.4	Process and Effluent Radiological Monitoring Systems
12.1	Area Radiation Monitoring System
15	Accident Analysis

As a result of considering the reclassification of SSCs and Accident Analysis in DSAR, EALs that are not applicable for plant defueled condition were removed and others were reasonably revised for consistency with DSAR.

2.3 Study of NEI guidance

NEI 99-01 "Methodology for Development of Emergency Action Levels" (Rev.6) was officially approved by NRC and it provides guidance for an emergency classification scheme applicable to a permanently defueled (PD) station.

According to this guidance, the owner of a permanently defueled station must demonstrate that

no credible event can result in a significant radiological release beyond the site boundary. Therefore, EALs applicable to a permanently defueled station may limited to only either a Notification of Unusual Event (NOUE) or an Alert classification. It means that PDEP may not need to cover Site Area Emergency (SAE) and General Emergency. Applicable Alert EALs for PD station are shown in Table 2.

Table 2. Applicable Alert EALs of NEI 99-01(rev.06) for Permanently Defueled Condition

EAL	Description
PD-AA1	PD-AA1 Release of gaseous or liquid radioactivity resulting in offsite dose greater than 0.1 mSv Effective Dose or 0.5 mSv thyroid Equivalent Dose.
PD-AA2	UNPLANNED rise in plant radiation levels that impedes plant access required to maintain spent fuel integrity.
PD-HA1	HOSTILE ACTION within the OWNER CONTROLLED AREA or airborne attack threat within 30 minutes.
PD-HA2	Other conditions exist which in the judgment of the Emergency Director warrant declaration of an Alert.

2.4 Case Study of U.S. Plants

Kewaunee Plant Station (KPS) is the first plant under decommissioning with the renewed NEI 99-01 Rev.06 (‘12) and its EP exemptions had approved based upon the reduction of risk to the health and safety of the public. For those exemptions, site specific spent fuel pool accidents analyses was performed (including beyond design basis accident) and their result should meet the conditions 1) the projected dose to the public is within the limit or 2) there is sufficient time to take mitigation actions and implement offsite protective measures if needed. After the exemptions were approved the PDEP was implemented. KPS was able to reduce the EALs, EP facilities, equipment, and ERO (Emergency Response Organization) which allowed reduction of plant staffing.

Zion Station also developed its EP plan for Defueled Station. The analysis of the potential radiological impact of accidents for Zion Station in a permanently defueled condition indicated that any releases beyond the Restricted Area Boundary (RAB) are limited to small fractions of regulatory guidance. For this reason, radiological emergency plan was focused onsite and reduced cases of EALs down to 6 Unusual Events and 4 Alerts without any Site Area Emergency and General Emergency (same as the NEI 99-01 guidance).

3. Conclusion

KHNP CRI developed the Emergency Plan for permanently defueled condition to meet the DSAR which involves revised SSCs, source terms, and accident analysis. The reduced EALs shown in Table 3 were derived as 11 Alerts, 7 Site Area Emergency, 4 General Emergency, by eliminating and revising the EALs for normal operation conditions. Just after defueled, the SFP source term condition is not very different from normal operating. But after a certain period of the time, exemption of EALs especially for Site Area Emergency and General Emergency would be possible. For this exemption, additional accident analysis (for design basis and beyond design basis) and discussion with regulatory body are required referring to guidance and cases of overseas.

Table 3. Reduced EALs for Permanently Defueled Condition of Kori Unit 1

EAL category	Number of Cases	
	Operation Condition	Permanently Defueled
Alert	20 Cases	11 Cases
Site Area Emergency (SAE)	17 Cases	7 Cases
General Emergency	13 Cases	4 Cases

REFERENCES

[1] NEI 99-01, “Emergency Action Levels for Non-Passive Reactors”, Rev.6 (2012).

[2] Zion Station, “Defueled Station Emergency Plan(DSEP)”, Rev.13 (2010).