Review on Precedents of Environmental Impact Assessment During Decommissioning of Nuclear Power Plants for Domestic Approach

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1. Introduction

Decommissioning of many Nuclear Power Plants (NPP) in advanced countries (USA, Germany, France and UK) has been started from later 1980s and various nuclear research facilities also have been progressed [1]. Especially USA and Germany, which have started nuclear power production earlier, adopted DECON (Immediate Dismantling) and completed several times to final stages of the decommissioning as site clearance and restoration for 'Greenfield' or 'Brownfield.

In Korea, not only end state nuclear facilities but also Kori unit 1 is about to set for decommissioning. Especially, plant locations are mostly clustered on sites that must be considered and identified in Environmental Impact Assessment (EIA) during decommissioning. Considering domestic site characterization and safety concerns from residual radioactivity, EIA during decommissioning is crucial process to determine use and remediation of the sites after decontamination.

However, these strategies and technologies for assessment are very different from country to country due to different sites' specific conditions and their pros and cons. It is essential to understand the decommissioning status and policy for the applied technologies in relations with our site dependent conditions in order to expect the prospects of decommissioning industries.

Based on reviewing of precedent technical cases of EIA of USA NPP decommissioning, we need to concern and make preparations for reliable research of domestic EIA in advance for future status in decommissioning projects. In addition, EIA should be formulate for our own strategies based on the terms of definition of decommissioning.

2. Analysis and Results

EIA of NPP includes all process about environmental impact considering remediation and reuse of site and detecting that of residual radioactivity for safety and conservation of public.

In Korea, based on experience review of decommissioning of research reactor, EIA is required mostly at 2 stages. One is detecting of residual radioactivity of source term to compare with Derived Concentration Guideline Level (DCGL) at level 2 of decommissioning. Another is at level 4 for site release and restoration during removal of building and structure surveys [2].

EIA progress is different from operating and decommissioning of NPP.

For the detailed EIA process of decommissioning is introduced and summarized at Fig. 1. below.

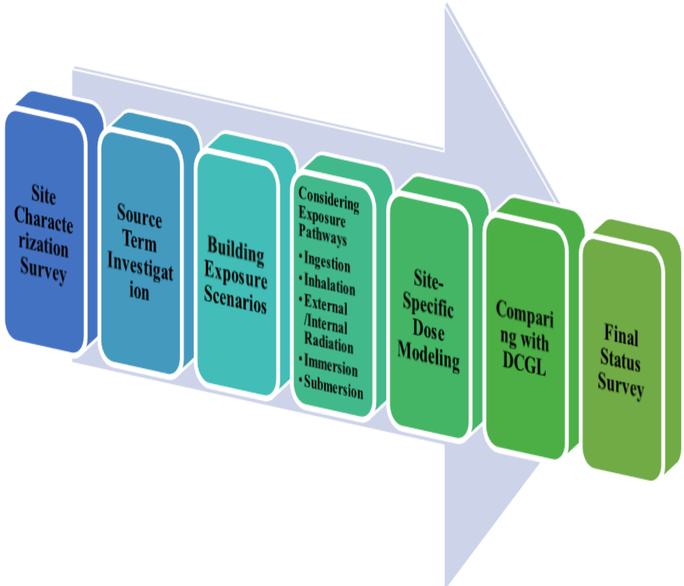

Fig. 1. Conceptual Illustration of EIA process during decommissioning.

2.1 HSA necessity for Source Term Detection

Considering domestic current status of decommissioning which will follow DECON, we sorted out similar decommissioned cases in USA with Kori unit 1 for further analysis. Connecticut Yankee (CY) and Maine Yankee (MY) are the same reactor type with Kori unit 1 for PWR and each output is 560Mwe and 860Mwe close to 587Mwe of Kori unit 1.

There are major highlighted lessons learned from these cases. In CY plant, severe toxicity radionuclide Strontium-90 (Sr-90) and Tritium (H-3) were discovered during groundwater monitoring. This issue led to additional expenses for site remediation [3]. Certain radionuclides can be released from soil due to groundwater or precipitation passing through the soil. If a radionuclide is easily mobilized, soil containing that radionuclides in sufficient concentrations can cause groundwater levels to exceed the groundwater criteria, which proved to be the case for H-3 and Sr-90 at CY [4].

In MY plant, major radionuclides were Cobalt-60(Co-60), Iron-55(Fe-55) and Cs-137 [4]. Co-60 and Cs-137 were common source term in both NPP and other radionuclides were vary from its specific site characterization. In addition, scope surveys furtherly progressed compared to CY. Scope surveys were divided into 3 categories as buildings, concrete and soil to decrease residual radioactivity for remedial action support survey [5].

Table 1. A comparative table of CY and MY [4, 5]

Name		CY	MY
Type		PWR	PWR
Capacity (MWe)		560	860
Operating Duration		28 yrs	25 yrs
Major Radionuclides	**Co-60**	3.5pCi/g	31.7pCi/g
	Cs-137	3.3pCi/g	1.2pCi/g
	Focusing Radionuclides	Sr-90	Co-60

During decommissioning, exact dose detection is not proper and accurate because of source term fluctuation. Historical Site Assessment (HSA) is to determine the extent and nature of the contamination at the site by reviewing incidents that occurred during the operation of a plant. This is prerequisite to complete decommissioning early since it will direct the characterization efforts and may determine how certain aspects should be conducted. The methods to conduct the CY HSA were plant photos and plant modification documentation to determine the fluctuation of soil into and around the site [4]. In this case, based on the results of the HSA, scoping surveys were conducted to determine the radiological status of the sites' system, structures and land areas. As result of the HSA and site characterization, the results of ongoing surveys were used to identify areas of the site that require decontamination as well as cleanup associated costs. In addition, those methodology aided the decommissioning of CY as it helped locating sources of groundwater contamination and other areas where remediation was needed. Overall, this case shows recommendation of site characterization especially for subsurface soil standard to be performed early in the decommissioning [4]. This is because consistent depth is required for determining DCGL and distribution of contamination source.

2.2 Possibility of Internal Exposure for Alpha Radionuclides

Alpha radionuclides through intake or inhalation leads relatively high internal exposure hazard to workers than external exposure during decommissioning [6]. Concerning alpha contamination as the first key step in this case. One factor that was determined during the collection of scoping survey information at CY was that the ratio of the beta/gamma emitting to the alpha emitting radionuclides was much lower than that at most other power plants. CY utilized special "alpha cam" continuous air monitoring equipment to check for airborne contamination in high alpha contamination areas. These ratios are used to set trigger levels for continuous air monitor alarms and the posting of areas as airborne contamination areas. Cost and duration time for decommissioning is determined by this method [4].

3. Conclusions

Conservation and protection for workers, public members and environment is an important responsibility of nuclear engineers. Therefore, baseline measurements and standards are needed for domestic environmental impact assessments. Based on review of CY and Maine Yankee cases, balancing with stakeholders and public is an additional issue in EIA. In addition, HSA and theoretical suite of radionuclides provide accurate exposure dose for human and standard of DCGL. For further use of site after decommissioning, site remediation has been considered as the final step in decommissioning of the nuclear facilities. For keeping pace with increasing tendency of decommissioning, effective EIA strategies during decommissioning are expected based on this study.

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