Experience Review of Components Decontamination for Decommissioned NPPs

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1. Introduction

Decommissioning of nuclear power plants generates large amounts of contaminated metal structures and waste of various equipment. On average, 30,000 to 500,000 tons of metal waste will be generated at the decommissioning of a commercial nuclear power plant. Nonetheless, appropriate equipment for decontamination of contaminated equipment has not yet been developed. If disposal is done without decontamination of contaminated metal structures or components, the amount of waste to be disposed becomes too much, which is expected to make it economically feasible to decommissioning Kori Unit 1 and to exceed the capacity of the repository. The metal decontamination technology, which is currently being discussed in Korea, is a wet treatment method. Due to the nature of the technology, when the oxide film is formed on the metal surface, the decontamination performance is significantly lowered and a large amount of secondary liquid waste is generated. In addition, it is expected that it will be difficult to secure the safety of workers [1].

Therefore, it is very important to acquire decontamination technology in accordance with the actual situation in Korea through foreign case study.

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2. Components Decontamination Activities

2.1 Objective

Currently, many decontamination technologies have been developed and applied to decommissioning sites. However, because of lack of data on application cases and efficiency, it is often the case that multiple technologies are used instead of single technology. Therefore, when decontamination techniques are applied, the following should be considered.

There are three purposes for decontamination of nuclear facilities. To reduce the amount of radiation in the facility by removing the contamination of the equipment or facilities. As a result, disassembly work in the facility is facilitated, and it is possible to save money by enabling people to work directly without using remote equipment. It is possible to prevent the spread of contamination due to the high radioactive material that may occur during the decommissioning process. Decontamination can reduce the contamination of the equipment, facilities or material, thereby making it possible to secure economic efficiency at the time of disposal and to enable recycling or reuse.

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2.2 Decontamination process

The chemical decontamination method necessary for the decommissioning of nuclear power plant refers to the chemical decontamination by circulating a chemical solution having a decontamination effect inside the system. Also included is a method of immersing part or the entire component in a tank containing a chemical solution. The chemical decontamination method is generally divided into a method using a noncorrosive solution and a method using a caustic acid or an alkaline solution. If the chemical contains 1~10%, it is called chemical decontamination, and if it is more than that, it is called chemical decontamination.

Fig. 1. Chemical decontamination (Medoc process at (BR3)

Currently, it uses wet abrasive blasting to decontamination metal surfaces such as component and structures of many nuclear facilities, and is used to remove corrosive substances and paint deposited on surfaces such as turbines and valves. A dry spray called sand spraying method or abrasive jet is a method of uniformly removing surface contamination by spraying an abrasive directly on a contaminated surface. Generally, a method of spraying using compressed air is used.

Fig. 2. hydrolazing decontamination [2]

Hydrolazing is suitable for decontamination of piping or internal equipment which is difficult to approach by spraying high pressure water of 10^5 ~ 10^8 Pa on contaminated part. Depending on the strength of the pressure, it is possible to remove paints, coatings, and corrosion layers.

Fig. 3. Abrasive blasting decontamination [3]

2.3 Experience of Decommissioned NPPs

In the case of Maine Yankee NPP, a soft abrasive such as sponge blasting was used to decontaminate the metal surface, or a solvent was used to remove the paint or oxide. Decontamination and investigations were carried out using "pipe crawlers" technology to decontaminate contaminated pipes from radioactive materials. This technology was used to reduce risks, decommissioning costs and secondary waste.

Table I: Relative Performance Factors for decontamination Techniques [4]

Types of technology	Abrasive blasting	Chemical	Hydrolazing
Performance Loose Contamination	High	High	High
Performance Fixed Contamination	High	High	Medium
Types of Substrate	Concrete, Metal	Metal	Concrete, Metal
Cost	Cost based on system	\$10-20/m^2	\$40/m^2

Trojan NPP used high-pressure spraying, grit blasting and chemical decontamination methods to decontaminate equipment and pipes. Although the pipes were highly contaminated, there was no corrosion inside the pipes because the pipe material was stainless steel. Therefore, the grit blasting method with the highest efficiency was used the most. The blasting equipment was placed in a low place in the nuclear power plant, and air was supplied to the blasting equipment using an air compressor. The blasting hose was installed to allow the use of various types of grit.

Shoreham NPP has decontaminated metal surfaces very effectively by adopting a decontamination method with a zirconia-grinding wheel for stainless steel appliances that have been in contact with cooling water for a long time. In the case of pipes made of carbon steel connected to the building floor and components, it was effectively decontaminated using high-pressure hydrolazing method of about 1,360 atm. The range of contamination of the equipment was found to be less than 1,000dpm / 100 cm^2 - 600,000dpm / 100 cm^2, and the main decontamination target in the contaminated equipment was Co-60. A variety of field tests were carrying out through literature review and expert consultation on instrument decontamination, and it was shown that effective use of 7-9 inch zirconia-grinding technology could effectively decontaminate 12 mm thick stainless steel. It has been found that decontamination using high pressure spraying at 680 atmospheres (10,000 psi) is effective when the surface is contaminated with a wide range of oxide films, such as spent fuel riders. In the case of the hydrolazing decontamination, drain piping was found to be effective for decontamination.

Table Ⅱ: Comparison of Components Decontamination for Decommissioned NPPs [4]

Name	Maine Yankee	Trojan	Shoreham
Type	PWR	PWR	BWR
Capacity (Mwe)	860	1095	820
D&D Duration	1997-2004	1996-2005	1989-1994
Scope of Decontamination	Embedded pipe, structure	Drain Piping, Ventilation Ducting, Process Pipe	Spent Fuel Pool Liner, drain piping, Condenser Hot cell
Types of technology	Wiping, Washing, Vacuum, Blasting, Pipe Crawlers	Grit abrasive blasting, Hydrolazing, Drilling	Hydrolazing, abrasive grinding, dry vacuum

3. Conclusions

To prepare for the decommissioning of Kori Unit 1, it is necessary to review the decontamination technology applied to the decommissioning of foreign nuclear power plants and to develop decontamination technology in accordance with the situation in Korea. It is necessary to develop dry decontamination technology capable of remote and automated facility operation in

accordance with the trend of overseas technology development. Most radioactive metal wastes generated from nuclear facilities are mostly surface contaminated. Therefore, it is necessary to develop technology that has excellent performance of decontamination of surface contamination to reuse / recycle of base materials while reducing the amount of waste. It is necessary to develop technology that can be applied to the decommissioning and decommissioning of large metal wastes such as steam generators that occur at the decommissioning site of old nuclear power plants in order to advance into the world nuclear decommissioning market.

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