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Experience Practices on Decontamination Activity in NPP Decommissioning

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1. Introduction

Decommissioning of a nuclear power plant (NPP) involves various technical and administrative activities for a utility to terminate its license, which allows the plant site to be released from the regulatory control (site release). Decontamination activity in NPP decommissioning is one of the main technical activities to be performed during the decommissioning. The decontamination at decommissioning sites is usually performed due to several reasons such as reducing personnel dose and disposal costs, and cleanup to meet license termination requirements by using physical or chemical removal techniques proven through the previous experience practices. This paper introduces the best and worst practices for the decontamination activities collected from the decommissioning operational experiences through the implementation of nuclear decommissioning projects around the world.

2. Best Practices

2.1 SSC Decontamination Using Physical Means

Rancho Seco NPP set up a grit blast booth to remove radioactive material from slightly contaminated sections of SSCs [1]. Sections were sized to fit into the grit-blasting booth and all necessary surfaces were exposed. After grit blasting a confirmatory survey was made of the component to see if it met free-release criteria. Approximately 1 million pounds of SSCs were processed in this fashion and free-released to be recycled or disposed as appropriate.

Yankee Rowe NPP successfully utilized in-situ decontamination that was performed prior to dismantling components [2]. Methodologies employed ranged from wiping off loose contamination, removal of paint from metal, to scabbling or scarifying concrete. This licensee did not use high-pressure water ("hydrolasers") out of a concern that this might spread contamination. In some cases, contamination was controlled by painting or otherwise covering the contaminated SSC prior to sectioning. This latter method virtually eliminated the spread of contamination. Contamination in spent fuel pool concrete has been determined to be more of a function of contamination and activity levels in the pools than the type of coatings.

The higher the activity, the further contamination is found in spent fuel pool concrete. Concrete has been successfully decontaminated using high pressure washing, scabbling, and/or planing using robotics or manual methods [3]. As one of the mechanical methods for the contaminant removal on the surface of the concrete, Figure 1 shows the clean-up of the Bradwell pond using the ultra-high pressure washing equipment supported on large floating platforms on the un-drained pond.

Fig. 1. Ultra-high pressure washing of the Bradwell pond.

2.2 Full System Decontamination (FSD)

Full system decontamination has been performed at several nuclear power plants to lower dose to workers dismantling the facility. Decontamination factors that would be acceptable for operating facility (e.g. 10-15) are eclipsed by those desired for decommissioning projects (e.g. greater than 100). For the FSD, Chemical Oxidation Reduction Decontamination (CORD) FSD process from Areva, Westinghouse's NITROX, and the EPRI-licensed Decontamination for Decommissioning (DfD) have been employed.

A review of the FSD experiences to date including the results in Table 1 has led to the conclusion that it is difficult to compare results of FSD at different facilities because of variability amongst plants with regard to run time, systems, history of failed fuel, decontamination scope, and so on [4]. Table 1 shows the comparison of the decontamination results from using the CORD process (Connecticut Yankee and Stade NPP), DfD process (Maine Yankee NPP) and [NITROX+DfD] process (José Cabrera NPP).

Table 1: Comparison of results to international FSD

Plant	Surface Area (m^2)		Metals Removed	Radioactivity Removed	Resins Generated	Decontamination Factors	
	SS	Inconel	(Kg)	Co-60 (Ci)	(m^3)	RCS	Aux. Syst.
Connecticut Yankee	1,997	929	182	129	13.2	17.6	9.8
Maine Yankee	465	139	307	99	15.1	8.7	44.8
Stade (1)	5,000	12,000	230	630 (total)	15.3	21.6-112	17.9
José Cabrera (1)	894	2,313	234	713.70	13.14	7.8-50.23	33.07

(1) The reactor vessel was included in the decontamination process

2.3 Hot Spot Reduction

Hot spot reduction is as important during decommissioning as it is at an operating facility in keeping personnel dose ALARA. The hot spot reduction program comprises two basic steps: the identification and then the removal of the hot spot. Historically, hot spots were identified through RP technician surveys which still are the primary method for identifying hot spots. However, new technologies such as a “gamma cam” or Cadmium-Zinc-Telluride (CZT) detectors allow rooms to be thoroughly surveyed to a degree not previously possible. CZT detectors have numerous advantages such as their small size, radioisotope identification, omnidirectional source identification, and the ability to overlay the radiation fields identified over a still picture of the area being surveyed [3].

Hot spot removal can be accomplished via the following methods: physical/mechanical removal, chemical removal, or through flushing. To eliminate hot spots some licensees have removed entire sections of SSCs after they have been taken out of service, de-energized, or drained, as appropriate. Often a licensee must evaluate the effect of hot spot removal on system availability. However under those circumstances other engineering controls may need to be implemented such as flushing or the installation of lead or tungsten shielding.

2.4 In-Situ Piping Decontamination

Trojan NPP decided to decontaminate piping in place to meet the free-release criteria instead of surgically removing the embedded piping for disposal to meet that goal. The scope of the project was large as the total length of contaminated piping in the plant was 29,000 feet (5.5 miles or 8.8 km). Stainless steel piping was decontaminated using media blasting technique, whereas carbon-steel pipe was cleaned using high-pressure water (“hydrolazing”) followed by high volume flushing. Success of the project was attributed to advanced planning, decontamination methods selected (from a large pool of competing technologies evaluated), integration of the decontamination work with other decommissioning work, and regulatory approval of the final contamination-level acceptance criteria [5].

3. Worst Practices

3.1 Full System Decontamination (FSD)

Connecticut Yankee NPP used the installed plant ion exchangers for removal of the radioactive contamination released from plant systems during the FSD, as well as for the cleanup of residual chemical from the process fluid. However, the material condition of the plant’s radioactive waste system had deteriorated in the period after shutdown and equipment failures occurred that hindered the progress of the chemical decontamination. The licensee noted that the material condition of plant components is a key to the success of the FSD. The FSD should be undertaken as soon as possible after permanent shutdown to ensure that systems are still functional and preventative maintenance on other maintenance is current. System failures add delays and costs to the FSD and total decommissioning cost.

4. Conclusions

Review of the experiences of decontamination shows that it is important to conduct an advanced planning for optimized implementation of decontamination taking into considering site specific conditions such as operating time, reactor type, system, and so on. Also, a review of newer decontamination methods is necessary to safely and economically decommission the nuclear facility. These lessons learned are expected to help successful implementation of decontamination activity during the domestic decommissioning including Kori Unit 1.

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