

Case Study of HSA at Zion Nuclear Power Plant

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1. Introduction

Related to decommissioning, the ultimate goal of the understanding of radiological status of a nuclear power plant is to release a plant from the regulatory control (site release) by demonstrating that the levels of residual radioactivity at the site meet the site release criteria. Generally, this demonstration is performed by implementing "Radiation Survey and Site Investigation (RSSI) process" for which four U.S government agencies including the Nuclear Regulatory Committee have developed the guideline (MARSSIM) [1].

This process uses a graded approach which starts with Historical Site Assessment (HSA) and is later followed by other surveys that lead to the final status survey (FSS). Therefore, the HSA is the first step in the Radiation Survey and Site Investigation Process.

The HSA, which is a detailed investigation to collect existing information describing a site's complete history in terms of radiological contamination from the start of site activities to the present time, should be performed as early as possible before a permanent shutdown occurs, because the HSA can be performed even during operation such that subsequent surveys whose planning needs inputs from HSA can be performed earlier.

So, this paper aims to perform technical reviews on the HSA experiences at Zion nuclear power plant.

2. HSA experience at Zion

2.1. General information

Zion is located on a 250 acre site near Zion, Illinois on Lake Michigan. Zion Station was a two unit pressurized water reactor facility which was rated at 3250 MWt and 1080MWe for each reactor. The four-loop pressurized water reactors were designed by Westinghouse Electric Company and built by the utility. Table 1 shows a history of Zion NPP [2].

Table 1 History of Zion NPP

	Unit 1	Unit 2
Commercial operation	December 31, 1973	September 17, 1974
Last operations	February 21, 1997	September 19, 1996
Announcement of permanent shutdown	January 15, 1998	

2.2. HSA Approach

As part of the transition of Zion Station from operating to decommissioning status, the HSA was begun. The HSA was performed to collect existing information (from the start of Zion Station's activities related to radioactive materials or other contaminants) for the site and its surroundings. During the conduct of the Zion HSA, information was obtained from over 300 current and previous Zion employees. Additionally, over 29,000 documents and databases were reviewed for the development of the Zion HSA. A preliminary HSA investigation was then performed. This limited-scope investigation served to collect readily available information concerning the facility or site and its surroundings. The investigation is designed to obtain sufficient information to provide initial classification of the sites or survey units as impacted or non-impacted. If impacted, an initial determination of Class 1, 2, or 3 was made according to MARSSIM. [3].

2.3. Radiological contribution from other source

Over the twenty-five year operational period of the facility, several instances were identified where environmental media showed elevated radioactive components, which were attributable to events other than operation of Zion Station. The following events were specifically noted in monthly reports documenting results of the REMP

Nuclear weapon test in China	June 27, 1973
Nuclear weapon test in China	mid-June 1974
Nuclear weapon test in China	September 26, 1976
Nuclear weapon test in China	October 17, 1976
Nuclear weapon test in China	September 17, 1977
Nuclear weapon test in China	March 1978
Nuclear weapon test in China	October 16, 1980
Chernobyl nuclear accident	April 26, 1984

All of these events produced both fission and activation products which entered air, water, soil and vegetation pathways surrounding Zion Station. Although most of the shorter lived radionuclides (e.g., Mn-54, Co-57, Co-58, I-131) will have decayed, longer-lived radionuclides (e.g., H-3, Co-60, Sr-90, and Cs-137) from these non-Zion events may likely exist in environmental media near Zion Station.

2.4. Operation radiological monitoring data

Throughout Zion Station's period of operation, radiological environmental samples and surveys were taken. Over the twenty-five year period the gamma exposure rates ranged from a low of 9.2 mR/quarter to a high of 20.8 mR/quarter. This is equal to a range of 4 - 9 μ R/h. These results indicate no statistically significant increases in gamma exposure rates due to plant operations.

2.5. Classification of area

2.5.1 Impacted area – Known and Potential

Those area and buildings which are known to be contaminated or potential have been classified as impacted areas. These buildings contain virtually all the radioactive materials and radioactive contaminants for the facility. Detailed characterization will be required to determine the remediation (if any) necessary. These areas were all initially categorized as Class 1. Due to a series of historic primary system to secondary system leakage through the steam generators, the following buildings contain known or potentially impacted areas. Detailed characterization will be required to determine the remediation (if any) necessary. Portions of these areas are initially categorized as Class 2, the remainder being categorized as Class 3. In addition, the roofs of all buildings within the protected area are categorized as Class 2 due to potential accumulation of low level contaminants from airborne effluent releases. Table 2 shows classification of impacted area at Zion.

Table 2 Classification of impacted area

Class 1	Class 2 or Class 3
Unit One Containment	Turbine Building
Unit Two Containment	Unit One Main Steam Valve House
Fuel Handling Building	Unit Two Main Steam Valve House
Radioactive Waste Building	Waste Water Treatment Facility
Auxiliary Building	Warehouse/Mechanical Maintenance Training Area
Interim Radwaste Storage Facility	Station Construction Building
East DAW Building	IDNS Building
West DAW Building	Gate House / Warehouse

2.5.2 Non-impacted area

Those area and buildings which are known to be non-contaminated have been classified as non-impacted. Detailed characterization will be required to verify this determination. Table 3 shows non-impacted area at Zion.

Table 3 Non-impacted area

Non-impacted area
NE Corner of Exclusion Area
Power House Area
NW of Switchyard
WNW of Switchyard
SW of Switchyard
Southern Area of DSAR
Met Tower Area
NW Corner of ComEd Property

3. Conclusion

Kori-1 is the first nuclear power plant the HSA were applies to in Korea. To perform the HSA, it is necessary to thoroughly investigate overseas experience cases. The results of the HSA at Zion show that several areas of the facility may require redemption prior to site license termination. The areas that will actually require redemption will vary depending upon the results of detailed site contaminant sampling and characterization, and upon the regulatory requirements in force at the time of the facility decontamination and dismantlement. Furthermore, the results show some instances where contaminants were inadvertently released from site.

Like the successful case of the HSA at Zion as mentioned above, HSA should be based on the collected information including operation history, radioactive material leakage, accident history, interviews and as much information as possible.

Based on these results, this paper is expected to help not only the licensee to performance of HSA at Kori Unit 1 but also the regulator to review the results.

REFERENCES

- [1] NRC, "Multi Agency Radiation Survey and Site Investigation Manual (MARSSIM) Revision1", NUREG-1575, 2000.
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- [3] Rock E. Aker, CHP, "Zion Station Historical Site Assessment", ComEd, 1999.