Review of MARSSIM Methodology for Nuclear Decommissioning Site Restoration and Environmental Impact Assessment

Young-hyun Lee*, Hyun-jin Park, and Je-geun Jeon*
Ujuenertech, 222, Wangsimni-ro, Seongdong-gu, Seoul, Republic of Korea
*820123j@naver.com

1. Introduction

According to Article 4 "Application for Construction Permit" of the Korean Enforcement Regulation of the Nuclear Safety Act, the content is mentioned, which should be drawn up according to what are set and announced by the Committee in a plan for the decommissioning of a reactor facility in accordance with Clause 2, Article 10. However, since no concrete methodology of that is mentioned, this study would review the methodologies of nuclear decommissioning site restoration and environmental impact assessment used in foreign countries.

South Korea already had a lot of experience of Final Status Survey (FSS), through the U.S. Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) that presents standards for various reactors decommissioning procedures, regulations and technologies for the decommissioning and site restoration of small low radiation facilities such as Research Reactors No. 1 and No. 2 and uranium conversion facilities.

MARSSIM refers to standard guidelines jointly agreed by all state agencies related to nuclear facilities in the U.S., such as Nuclear Regulatory Commission (NRC), Environmental Protection Agency (EPA), Department Of Energy (DOE) and Department Of Defense (DOD) for site environmental radioactivity survey according to nuclear facility decommissioning, which is methodologies and standard procedures based on dose or risk for the relevance judgment with regulatory requirements.

MARSSIM procedures suggest methods for fulfilling planning, performance, assessment and decision to determine whether radioactive contamination on the ground and building surface meets the standard value in each site in providing comprehensive guidelines for the processes of the measurement and decision on contaminated soil and building. In addition, it is recommended to set a plan of survey on the site with contaminated ground and building surface, investigate the scope of the performed work, characteristic technologies, restoration measures and final status and perform quality assurance and management necessary for assessment of nuclear facility sites that have long operated and the acquisition and analysis of data. The purpose of FSS suggested by MARSSIM is to prove that residual contamination is less than Derived Concentration Guideline Level (DCGL) in nuclear facility decommissioning based on the standard for judging the satisfaction with regulatory requirements according to dose or risk at the stage of FSS.

2. Methodology

2.1 Procedures of environmental impact assessment in decommissioning nuclear facilities

MARSSIM limits the range just through a characterization assessment for the contamination of the surface of a building and the soil within 15cm under the topsoil and usually suggests guidelines for FSS. According to Radiation Survey and Site Investigation Process (RSSI) suggested by MARSSIM, it is recommended to conduct a Historical Site Assessment (HSA) first. Later, scoping survey through field investigation, check characterization survey showing the detailed contents of the contamination level and remedial action support survey are conducted. For FSS, the class of the irradiation area is modified. The location of sampling and the number of samples for accurate measurement are determined, and then, the contamination level of the relevant site is measured.

HSA determines the present status of the site of the decommissioned nuclear facility and classifies the contamination area according to the potential contamination. Through an assessment of the mobility of contaminants, classes are divided according to the latent contamination level of residual radioactivity, as shown in Table 1 below.

Table 1. Division of classes according to the contamination level

Contamination area	Classification
Class 1	An area with a contamination level higher than DCGL based on the latent

	radioactive contamination level according to the operating history or the previous radiation measurement
Class 2	An area with contamination based on the latent radioactive contamination level according to the operating history or the previous radiation measurement but with the contamination level not exceeding DCGL
Class 3	An area without any residual radioactivity or with a residual radioactivity level much lower than DCGL

The classes divided based on HSA may be changed through a detailed activity of survey on the pollutant range.

After measuring natural radioactivity to measure the accurate radiation level, it is necessary to refer to the grid coordinates provided by MARSSIM for the survey site.

In general, since the Decontamination and Decommissioning (D&D) activity is contaminated with multiple nuclides, it is necessary to know a relative radioactivity ratio of each nuclide to induce DCGL of most nuclides in DCGL for each nuclide. Generally, it can be known through alpha and gamma spectroscopy analysis.

In South Korea, as for the dose standard to open a site, the level of individual radiation exposure to residual radioactivity in a critical group should not exceed 0.1 mSv (effective dose) per year. This standard for exposure dose should be applied in order to draw DCGL. Especially, to prove that this condition of exposure dose is met, it is necessary to classify survey areas into a large number and conduct the survey according to the procedures according to potential contamination and expected residual radioactivity level based on the records of the operation of facilities like a site after decommissioning, records of decommissioning and records of radiological environment survey.

It is necessary to judge whether to open facilities by calculating DCGL applying a standard value and compare the FSS result with the DCGL based on all exposure pathways and scenarios that may actually occur if the relevant site is opened after the permanent suspension of the related facilities including nuclear facilities through these methodologies.

3. Conclusion

As a result of a review of NRC MARSSIM methodologies, the examples of the application of FSS in decommissioning the facilities utilizing nuclear power are as follows:

1. Preparing a survey
2. Checking source terms
3. Calculating DCGLw
4. Classifying contamination areas
5. Differentiating survey units (Building/soil)
6. Selecting measuring instruments
7. Selecting a representative referential area
8. Removing machinery/equipment from the measuring area
9. Designing a survey
10. Conducting a survey
11. Evaluating survey results

It is judged that it would be desirable to apply the regulations and technologies (procedures) proposed in NRC MARSSIM, taking into account that there is a nuclear decommissioning-related law in South Korea, but it is insufficient, and it is expected that many studies would be conducted in decommissioning the facilities utilizing nuclear power and developmental methodologies would come out.

ACKNOWLEDGEMENT

This study is being conducted with support for the project of Korea Institute of Energy Technology Evaluation and Planning.

REFERENCE

[1] NRC et al., “Multi-agency Radiation Survey and Site Investigation Manual, Revision 1” (2000).

[2] S.Y. Jo, “Dose Assessment using RESRAD-BUILD Code for Decommissioning of Nuclear Fuel Cycle Facility” (2011).

[3] J.S. Min, K.W. Lee, H.R. Kim & C.W. Lee, “Radiological Assessment of the Decontaminated and Decommissioned Korea Research Reactor-1 Building”, Nuclear Engineering and Design, 322 (2017) 492-496.

[4] S.B. Hong, D.S. Hwang, G.W. Lee & J.K. Mun, “Drawing the Opening Standard after decommissioning Uranium Conversion Plant”, Annual Spring Conference of The Korean Association for Radiation Protection, (2011).

[5] E. W Abelquist, Decommissioning Health Physics: A Handbook for MARSSIM Users, CRC Press, (2013).