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# Development of Survey Procedures and Measurement System for the Detecting concentration of residual radioactivity in Decommissioning of NPP

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## 1. Introduction

As the country's first commercial reactor, the Kori No.1 reactor, was permanently shut down in June 2017, it is required to apply for approval for decommissioning by 2022. The Nuclear Safety Act regulates that the plan shall describe the methods and procedures for the survey types, quantities and distributions of radioactive materials at the facilities and sites subjected for the application for approval of decommissioning.

In addition, in order to complete the decommissioning, the nuclear operator shall present radiological survey plans, methods, results and reuse plans of the sites for the final state and demonstrate meeting the dose criteria.

Therefore, in decommissioning of Nuclear power plants, the detection of residual radioactivity at the site is an important and basic activity that establishes the plan, verifies the final radiological state of the site and determines the time and cost of the work as a result.

In this study, developed a system for detecting residual radioactivity to determine the effects of the activity, the scope and characteristics of contamination, and a procedure to survey contamination levels of soil surface using this system.

## 2. Methods and Results

### *2.1 The Measurement System*

The measurement system contains two instruments, the Unmanned Vehicle for Detection (UVD) for soil surface survey and the Soil Sampling Equipment (SSE) for samplings.

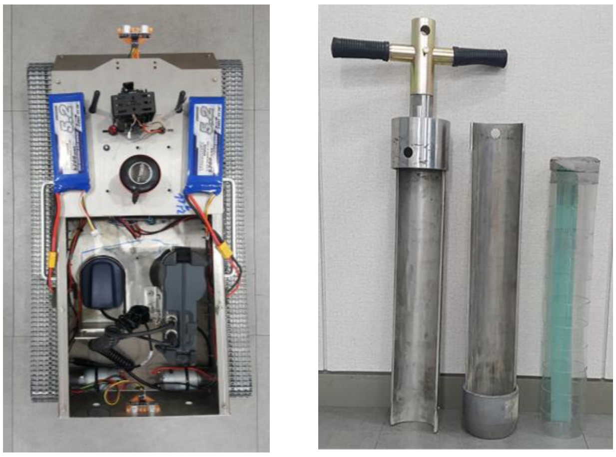
The UVD consists of a stainless-steel body and two detectors (scintillation, GM tube).

It can conduct convenient and uniform measurements of surface at large area, and map the result using colors to increase the efficiency of the task.

There are main functions:

1) Remote control: Long-range remote control using 2.4 GHz wireless communication and GPS
2) Ultrasonic sensors attached at front and rear: preventing damage to the instrument due to collision with obstructions on the move
3) Video transceiver: Checking the surrounding situation and working environment in real time
4) Color mapping: Checking contamination levels by location and visualization of the result

The SSE is made of stainless-steel, which can be obtained with undisturbed soil samples up to 50 cm from the surface. The acrylic cylinder inside the body can be separated by 5 cm each, which helps to classify samples by depth.



(a) (b)

Fig. 1. The Measurement System for detecting concentrations of residual radioactivity
(Unmanned Vehicle for Detection(a), Soil Sampling Equipment(b))

### *2.2 Planning Surveys*

The planning requires a pre-investigation of the site and it is mostly carried out in the Historical Site Assessment (HSA).

The requisite information is as follows:

1) Surrounding structures and underground utilities
2) Obstructions
3) A history of the contamination
4) The radionuclides of interest

Based on data of history of the contamination collected from the HSA, the site is classified into a Non-impacted area or an Impacted area. An Impacted area is where radiological measurements are required due to potential contamination, and a reference coordinate system shall be established and noted obstructions to ensure reproducibility of measurement locations.

In addition, an area which approximated environmental conditions of an Impacted area is chosen as a reference area for detecting background level.

*2.3 Preparing a Scan Survey*

In this step, divide the Survey Unit into the reference coordinate system based on the plan, route the Scan Survey path and check the operation of the instrument.

The number of Survey Unit can be adjusted according to the expected levels of contamination, and when drawing Survey Unit on the site, it is recommended to use substances of a powder-type that has no radiological effects, or an easily recognizable.

There are three ways to route:

1) Click on the point on the map shown in the Mission Planner, operating program for the UVD
2) Input of GPS coordinates in the Mission Planner
3) Use the cruise control

Since the UVD operates based on wireless various communication technologies, Check a normal operation before use. At this time, you can be used statistical test($\chi^2$ test) or check source to verify normal operation of the detectors.

*2.4 Conducting a Scan Survey*

When measuring by the UVD, need to separate the window from the soil surface, detecting the surface radiation dose rate and the contamination of surface, each 10 cm and 1 cm.

For information on measuring, see ‘KS A ISO 11932, activity measurements of solid materials considered for recycling, re-use or disposal as non-radioactive waste’, or any related standard documents.

*2.5 Planning a Sampling*

Since sampling to identify radionuclides in samples requires different levels of effort for each purpose, the point, number, and depth corresponding to the purpose are selected. And recording these above on the prepared reference coordinate system to ensure reproducibility.

Table I: Method of Sampling According to Purpose of Survey

| Objective | Method |
|---|---|
| Identification of Scope and Redistribution of area | • Professional judgement<br>• when re-classify the area, areas that are not expected to contain any residual radioactivity or exceed partially: Random |
| Characteristic Survey and planning a Remedial action | • Combine Systemic method and professional Judgement<br>• Flexibly select according to infiltration characteristic of soil<br>• consider depth of measurement up to 15 cm from the surface |
| Verifying Final site status | • Using a statistical test, WRS test or Sign test |

Identify the radionuclides of interest from the HSA data. Although it does not directly affect soil sampling, it is important to establish plans of pre-treatment and nuclide analysis.

*2.6 Preparing a Sampling*

The site to be sampled is a reference area and Survey Unit, both of which check the soil hardness, and equip pile machine. If electricity or cooling water is required to use the machine, determine the location and availability of them around it.

The acrylic cylinder is put into body of SSE and removes bumps by using tape, etc. to prevent soil from getting caught in the groove on the side of the equipment during burrowing. After that, fix the machine on the top to complete the sampling preparation.

*2.7 Conducting a Sampling*

The extruded soil samples in the acrylic cylinder are kept each depth-specific the samples separately to verify the distribution of radionuclides. For each depth, ensure sufficient sample volume required for pre-treatment or nuclide analysis methods. After that, select appropriate storage methods and containers according to the characteristics of samples collected, and record the information generated from sampling.

For information on sampling, see ‘KS A ISO 18589-2, Measurement of radioactivity in the environment - Soil - Part 2: Guidance for the selection of the sampling strategy, sampling and pre-treatment of samples’ or any related standard documents.

*2.8 Conducting a Pre-treatment and a Radionuclide analysis*

Apply to appropriate methods of Pre-treatment and Radionuclide analysis depending on the target nuclide to produce sufficiently reliable results.

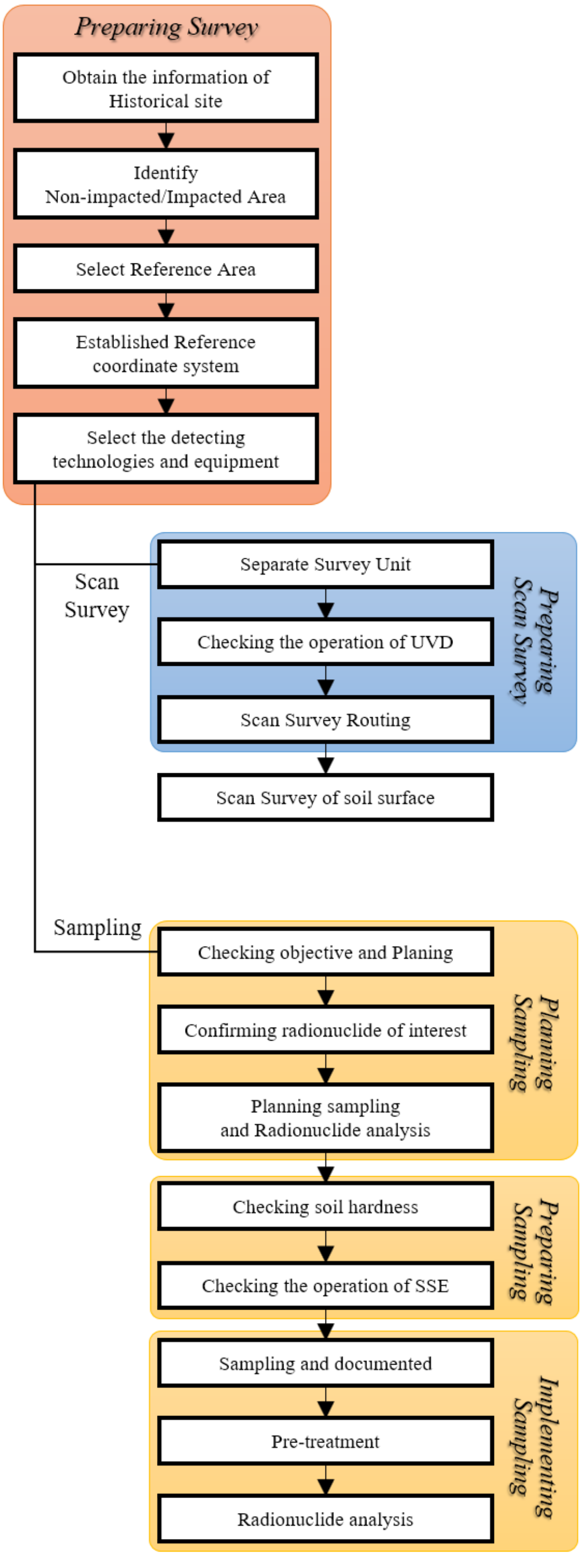



Fig.2. The Survey Procedures for the Detecting Concentrations of Residual Radioactivity

## 3. Conclusions

In this study, the measurement system and survey procedure for detecting concentrations of residual radioactivity of the site were developed. However, it is necessary to systematize the data derived from each procedure by preparing a database that is applicable to domestic conditions. In addition, it is necessary to evaluate the applicability of Nuclear power plants in Korea through further verification, the demonstration, of radioactive similar environments and decommissioning of Nuclear power plants based on the measurement system developed.

## 5. Acknowledgments

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## REFERENCES

[1] Sin,S.W., Study on the safety evaluation method development for D&D of Nuclear Power Plant, KINS/HR-588, pp. 53-76, 2004

[2] U.S. NRC, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG-1575, 2000