

A Study to Suggest the Sequences and Considerations of Soil Sampling for Nuclear Verification

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1. Introduction

There are countries that officially or informally abandon nuclear weapons for a number of reasons. At this time, the IAEA-led verification of denuclearization begins. Nuclear verification activities are required for not only reported nuclear facilities and materials, but also unreported nuclear facilities and materials for complete denuclearization.

The most powerful and reliable method of verifying denuclearization is to collect and analyze evidence. Sampling is the first step in this process, and it must be accurate and consistent. Therefore, a clear procedure is essential.

In this study, the overall procedure for soil samples around a nuclear facility was studied to track nuclear activity. Soil samples around the nuclear facility are likely to contain large amounts of evidence of nuclear activity.

2. Procedures

The verification process for denuclearization proceeds in an atypical form depending on various conditions such as the type of country or the amount of nuclear material possessed. Therefore, sampling studies in preparation for denuclearization should anticipate a comprehensive scenario and consider the procedures to follow[2].

Persons who participate in the denuclearization verification for sampling are classified into managers and collectors. Managers should identify and prepare for the elements necessary for the pre- and post-sampling process. In particular, it is necessary to understand the safety of the sampler, the sampling situation, and various problems at the sampling area and respond appropriately. Collectors collect samples according to the manager's instructions and predetermined procedures. By this division of roles, procedures are also divided according to roles.

2.1 Overall flow chart for the management view

The manager in charge of soil sampling should manage the entire operation from the preparation to sampling to the area, sample collection, movement, pretreatment, and analysis. Following the flow chart shown in Figure 1, manager can confirm that there are no misses in a whole part and connect each step systematically in order to perform the task.

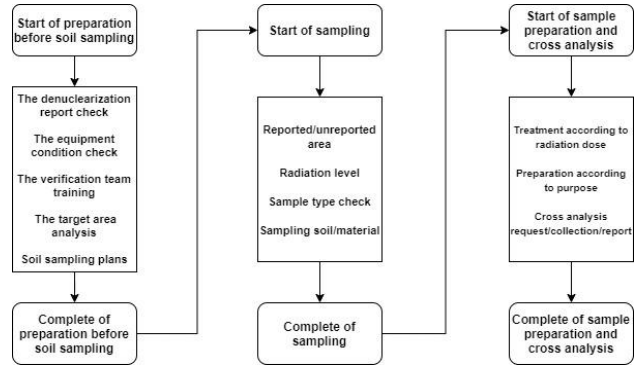


Fig. 1. The flow chart for management view

2.2 Preparatory sequence before going to area

Before going to the target area, preliminary investigations and preparations are required.

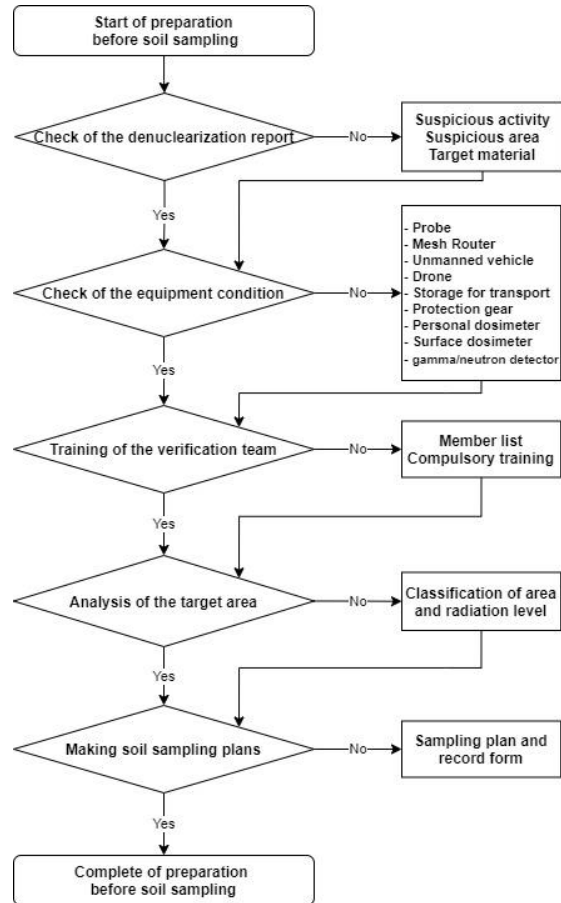


Fig. 2. The flow chart for determining sampling scenario

First, referring to the contents of the denuclearization agreement report and the suspicious activities, the target area for soil sampling and the predicted materials are checked and confirmed. Second, the condition of the equipment that will be used in a target area is inspected. For a work in the radiation areas, various preparations such as checking unmanned equipment, providing protection tools, and securing personal dosimeters are essential. After that, the training of the verification team is carried out so that it can do its tasks well in the real situation. Lastly, soil sampling plan and sampling record form should be made according to the target area information, when sampling, the sampler must fill in the details of sampling in this form.

2.3 Sequence of sampling scenario in the area

When the verification team arrives at the area, Sampling work base is established and proceeds to the steps shown in Figure 3 to determine a scenario for soil sampling. The main check list includes report-to-area correspondence, additional suspicions and radiation dose levels in the area. Based on these contents, it is largely divided into four scenarios:

- Manned soil sampling for detection of specific nuclear materials
- Manned soil sampling to detect local environmental information
- Unmanned soil sampling for specific nuclear material detection
- Unmanned object sample collection for specific nuclear material detection

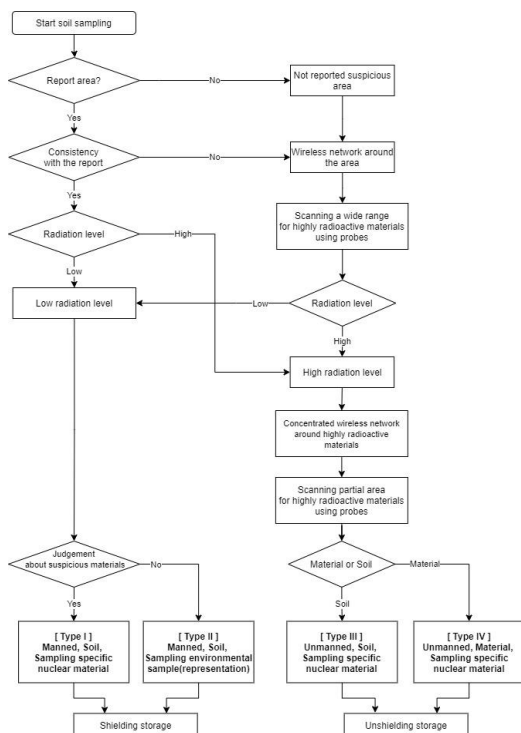


Fig. 3. The flow chart for determining sampling scenario

Depending on the scenario, the sampling sequence and storage of the samples might be different.

2.4 Flowcharts for each sampling scenarios

After all discussions and preparations have been completed according to the above-described flow chart, the sampling tasks in the target area will be carried out.

In a low dose area, the person puts on the protection gear with necessary equipment, and enters the sampling point. The sampler collects additional environmental information, samples soil using a sampling tool, and after all samplings, returns to the central verification center.

In a high dose area, after additional scanning in the partial area, an unmanned ground vehicle instead of the person is used for performing similar steps to person sampling steps. In this case, samples should be transported in a specially designed shielding storage. Figure 4, 5 are detailed flowcharts of four scenarios configured according to standards.

3. Conclusions

Republic of Korea needs to make various preparations in order to play a leading role in the process of denuclearization of neighboring countries. Therefore, it is necessary to develop technologies and procedures related to soil sampling. So, in this study, flow charts of soil sampling were organized for verification of nuclear activity. Using these charts, we will increase the application possibility by performing and modifying sampling activities assuming the actual situation. In addition, the target radionuclide is set for each nuclear facility and the sampling scenario is to be subdivided in cases. We hope that this study can contribute to quickly responding with future denuclearization situations and having a sufficient ability for nuclear verification.

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- [2] Jung Yoon Choi, Jihye Seo, Dong Yeong Kim, and Myungsoo Kim, Strategy Against the Investigation of Soil Samples for Denuclearization of Neighboring Countries, Proc. Of the KRS 2020 Spring Conference, Vol.18, No.1 p.49 ~ 50, 2020.

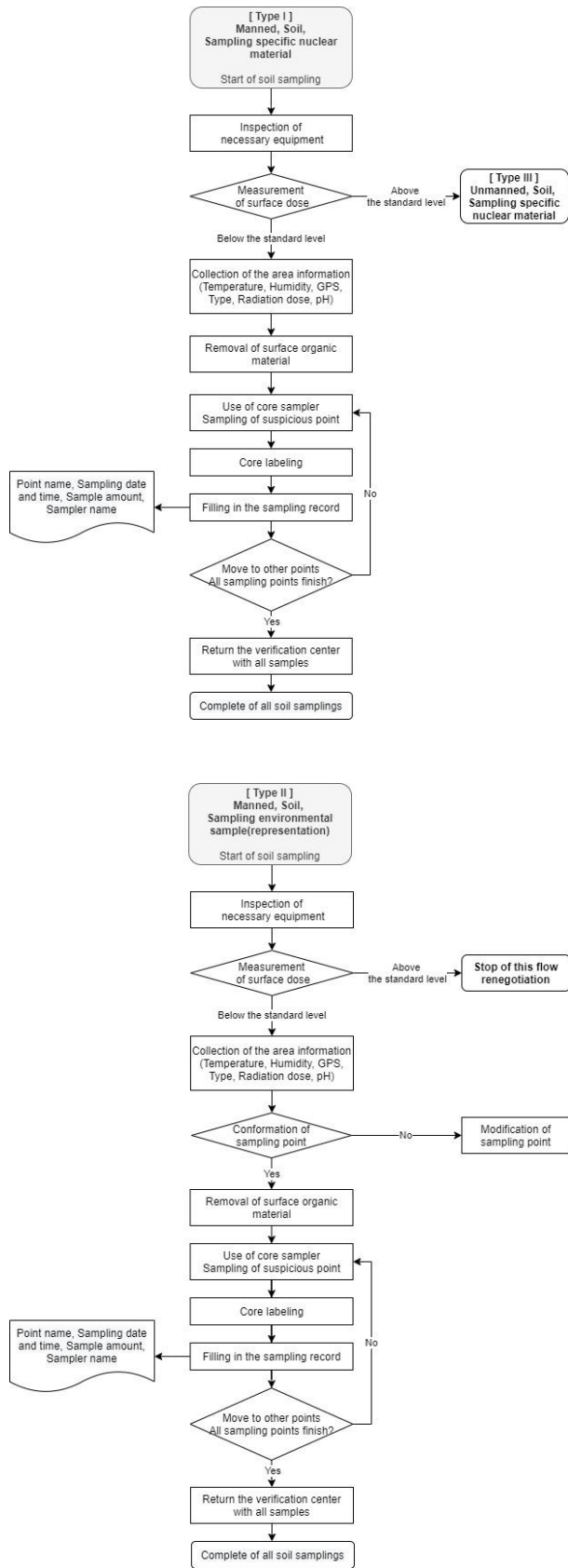


Fig. 4. The flow chart for manned sampling scenarios

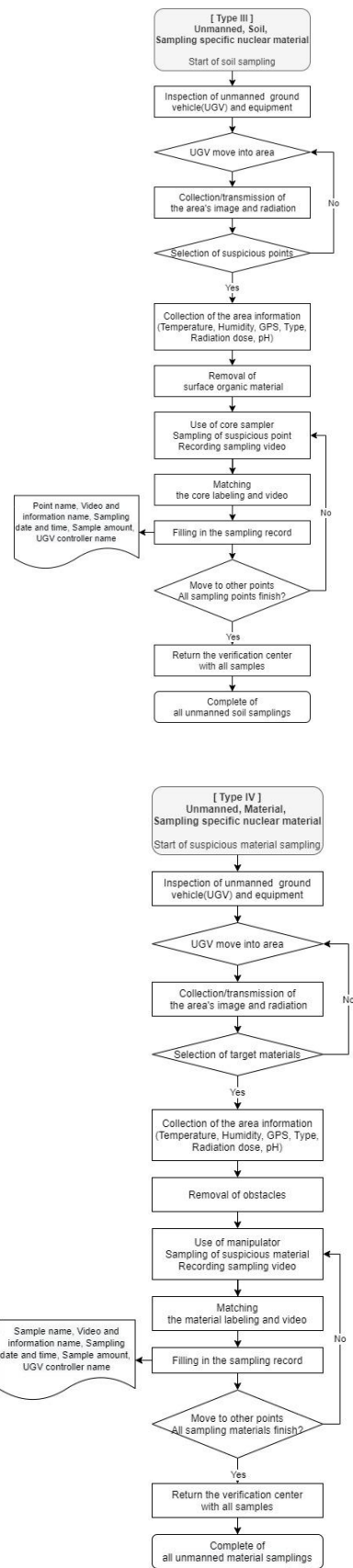


Fig. 5. The flow chart for unmanned sampling scenarios