# A Study on Assessment of fulfill the Site Release Criteria based on Site Survey data and DCGLs

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## 1. Introduction

The DCGL(Derived Concentration Guideline) is set up to demonstrate compliance with the site release criteria which is requires prior works such as sampling, measurement and selection of suitable radionuclides and so on. The NSSC (Nuclear Safety and Security Commission) Notification 『Criteria for Reuse of Site and Remaining Buildings after Decommissioning of Nuclear Facilities』 [1] comment that the fulfillment of DCGL in site can be assessed by total inspection or statistical method for each survey unit.

MARSSIM(Multi-Agency Radiation Survey and Site Investigation Manual) encourages the use of Data Life Cycle to plan and implement site surveys and make decisions based on DQO(Data Quality Objective)[2]. Figure 1 shows the 7 steps of DQO.

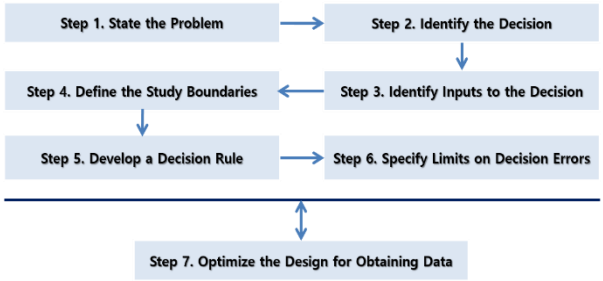


Fig. 1. 7 Steps of DQO

In the fifth step of DQO, the decision rule represented by 'Action level(e.g. DCGL)' is established. Based on a decision rule, the sixth step confirms the tolerance range for the decision error. In this process, the 'Gray region' set a range where the effect due to the decision error is considered to be relatively small. The gray region must be specified to make accurate decision with respect to important decision(e.g. fulfillment of DCGL), when the actual measured value is very close to action level.

In this study, we designate DCGLs of Kori-1 that is derived from the advanced research as the action level and indicated a method of making decision by statistically determining the fulfillment of site release criteria.

## 2. Making Decision Rule and Designation the Gray Region [3]

As a representative example, the decision rule for a survey unit is defined as 'the concentration of a radionuclide in survey unit will be x pCi/g', and the null hypothesis is defined as 'the concentration of survey unit will exceed the action level'. To specify the gray region, the decision error must first be identified. There are two kinds of errors that can be identified. Type I error is that the survey unit is determined to be released when the actual average concentration is higher than the action level. It is only decision error that can be occur if the actual concentration is above the action level. Type II error occur when the null hypothesis is false, but not rejected. Namely, it means that the survey unit where actual average concentration is lower than the action level may not be released. It is only decision error that can be occur if the actual concentration is lower than the action level. The gray region is designated as a relatively small area of type II error, and its width is determined by setting the distance from the most important point at which the occurrence of the type II error should be prevented. Generally, a typical case where the consequences of Type II errors can be considered serious is when site remediation is required for public health, even though the actual average concentration is lower than the action level and thus meets site release criteria. In this case, the range of gray region is set with the average concentration value of the survey unit as the lower limit. Figure 2 is diagrammatic representation of gray region according to action level.

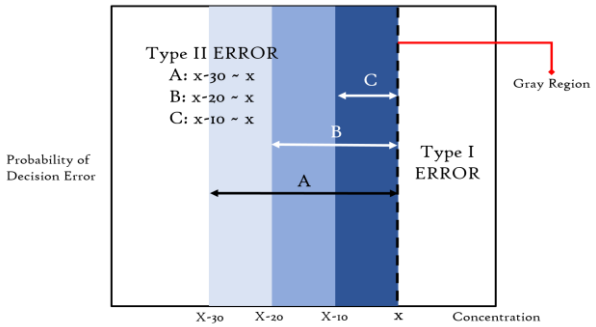


Fig. 2. The action level and setting of gray region

In the figure 2, if 'x' is the action level, the average concentration of survey unit is about 'x-30' for A, 'x-20' for B and 'x-10' for C. The gray region should be set carefully, taking into account overall requirements of the site survey activity, decision maker's concerns, cost of data collection, and whether DQO is met.

## 3. The Method of Making Decision using DCGL

In order to construct a gray region, it is necessary to specify 'the region of interest' which is a range of

possible concentration values. The region of interest generally specifies a range of expected minimum and maximum concentrations. In this study, based on the DCGL of radionuclides derived by using site environment data and RESRAD-ONSITE code in advanced research the region of interest was set [4]. According to MARLAP(Multi-Agency Radiological Laboratory Analytical Protocol Manual), generally the region of interest can be specified as 0.1 to 10 times the action level. In this study, we designate 0 ~ 2 times as the region of interest and assume a normal distribution model with 10 SD(Standard Deviation) and 90% confidence interval. The DCGLs of each radionuclide and the region of interest mentioned above are given in Table I.

Table I: The DCGLs and Region of Interest Radionuclides for Kori-1

| Radio-nuclide | Kori-1 Industrial worker $DCGL_w$ [pCi/g] | Region of Interest [pCi/g] |
|---|---|---|
| $^{134}Cs$ | 2.40E+01 | 0 ~ 4.80E+01 |
| $^{137}Cs$ | 5.70E+01 | 0 ~ 11.4E+01 |
| $^{60}Co$ | 1.34E+01 | 0 ~ 2.68E+01 |
| $^{90}Sr$ | 4.33E+03 | 0 ~ 8.66E+01 |
| $^{63}Ni$ | 1.60E+07 | 0 ~ 3.20E+07 |

The gray region should be established to prevent the type II error and within the region of interest. As mentioned above, the range of gray region can be specified by consultation between the decommissioning personnel, statistician, and decision makers based on DCGLs, which is an action level.

The following equation is an example of concentration range that can be estimated by the DCGL of Cs-137 in Table I, for the statistical model mentioned above.

$$57 \pm 1.64\sigma = 57 \pm (1.64 \times 10) = 40.6 \sim 73.4 \quad (1)$$

The lower limit of the gray region for assessment can be set to 40.6 pCi/g according to the concentration range derived from equation (1). An example of the decision rule for the concentration range and the lower limit of Cs-137 is given to Table II.

Table II: The Decision Rule for Cs-137

| Case 1 |
|---|
| Decision Rule: The concentration of $^{137}Cs$ is 40.6 pCi/g or more. |
| Interpretation: The actual concentration may be above the DCGL(57 pCi/g). There is no good reason to reject the null hypothesis. |
| Case 2 |
| Decision Rule: The concentration of $^{137}Cs$ is less than 40.6 pCi/g. |
| Interpretation: It can be considered that the actual concentration is less than the DCGL(57 pCi/g). |

When the measured concentration value for Cs-137 is 57 pCi/g or more, if the survey unit can't be released because the DCGL, the null hypothesis that the actual concentration is generally above 57 pCi/g or more can be set to minimize the occurrence of Type I error(It determined that the actual concentration is lower when it is actually higher than the DCGL.). If the measured concentration is not 40.6 pCi/g or less, it is assumed that the actual concentration is 57 pCi/g or more, and it can be decided that the site release criteria are not fulfilled. Conversely, if the measured concentration is less than 40.6 pCi/g, the actual concentration may be less than 57 pCi/g. Therefore, the null hypothesis may be rejected and it can be decided that the site release criteria are fulfilled.

## 4. Conclusions

In this study, we proposed a method to make a decision based on the basic statistical hypothesis test using the DCGL. The site survey data used to make a decision should be a technical quantitative value through the statistical hypothesis test considering the uncertainty, not a simple value represented by the mean or maximum value. In the process of decommissioning NPP(Nuclear Power Plant) in future, it is necessary to reflect the data life cycle based on the smoother communication between experts, regulatory agency and NPP operators, etc. The process of make a decision should be in accordance with the DQO set in the site investigation planning stage. In addition, follow-up actions such as the DQA(Data Quality Assessment) should be taken to improve the reliability of decision.

## REFERENCES

[1] Nuclear Safety and Security Commission(NSSC) Notification, Criteria for Reuse of Site and Remaining Buildings after Decommissioning of Nuclear Facilities, 2016.
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