

Principal Research Results

New Surface Contamination Measurement Method at Nuclear Power Plants – Demonstration of Applicability of Clearance Automatic Laser Inspection System for Surface Contamination Measurement –

Background

In the clearance level inspection * 1 of solid materials such as metal and concrete scrap generated from nuclear power plants, the activity level of waste must be compared with not only the clearance level (0.1 Bq/g for Co-60) but also the surface contamination density standard (4 Bq/cm² for beta or gamma emitter). Usually, a manual GM survey meter based on beta-ray detection is used for surface contamination density inspection at present.

Recently, the clearance automatic laser inspection system (CLALIS) has been developed for low-level radioactive waste measurement. The radiation detection ability for scrap metals and concrete segments has been clarified in a large number of experiments using mock metal and concrete waste samples and standard radioactive sources. It has been experimentally shown that the detection limit of CLALIS is approximately 100 Bq for Co-60, which is sufficiently low not only for clearance measurement, but also for surface contamination density measurement.

If clearance level and surface contamination density standards can be confirmed in a single radiation measurement with CLALIS, rational clearance-level inspection can be achieved (Fig. 1). For this, it is necessary to demonstrate the applicability of CLALIS for surface contamination measurement using actual waste generated from a nuclear power plant.

Objective

This study aims to demonstrate that CLALIS can be used for the measurement of surface contamination density by comparing the measurement results of CLALIS with those of conventional GM survey meter using various shapes and radiation levels of metal scrap generated from a nuclear power plant.

Principal Results

1. Experiment at nuclear power plant.

The 97 measurement samples of various shapes and different radiation levels (less than detection limit, less than 4 Bq/cm² and above 4 Bq/cm² by GM survey meter measurement) were chosen from scrap metal waste dump at Kashiwazaki-Kariwa Nuclear Power Station of Tokyo Electric Power Company. By comparing the measurement results of CLALIS with those of the GM survey meter, it is clarified that the CLALIS has equivalent surface contamination density classification ability of GM survey meter for all measurement samples (Fig. 2, Table 1).

2. Verification of applicability

To discuss the applicability of CLALIS as surface contamination monitor in practical use, detection limit and measurement time were estimated using the average BG count rate during the experiments at the nuclear power station. As a result, it was found that detection limit of CLALIS would be approximately 0.8 Bq/cm² in the case where the measurement time is approximately 1 minute, which is equivalent ability of present surface contamination monitors.

Future Developments

We aim to achieve practical application of CLALIS to a nuclear power plant in operation, and standardization of the surface contamination measurement method based on gamma-ray detection.

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Reference

M. Sasaki, et al., 2009, "Verification of surface contamination density standard using Clearance Automatic Laser Inspection System for objects from a nuclear power plant", CRIEPI Report L08007 (in Japanese)

* 1 : Nuclear power plant operators implement the measurement to confirm that the measurement target is to be "an object which is non-radioactive material", and the regulatory authority is involved in the judgment appropriately (Clearance Inspection Report, Nuclear Safety Commission of Japan, 2001). The target of clearance inspection is limited to solid materials.

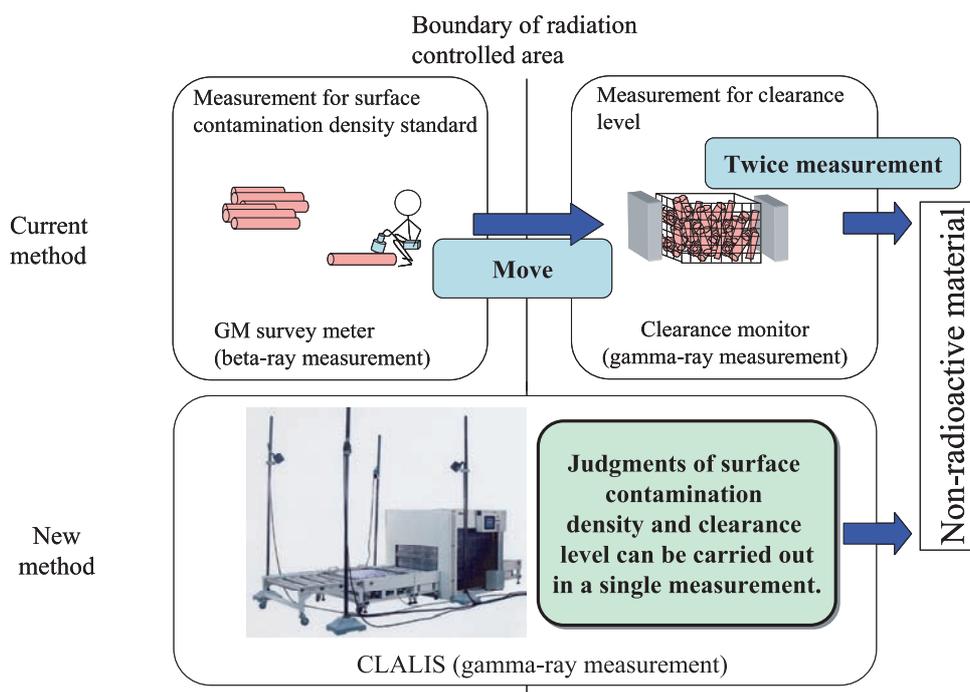


Fig.1 Rational clearance inspection using CLALIS



Fig.2 Verification test at Kashiwazaki-Kariwa Nuclear Power Station of Tokyo Electric Power Company

Table 1 Comparison between numbers of samples with different surface contamination density classifications for CLALIS and GM survey meter

GM survey meter \ CLALIS	CLALIS		
	LTD	Less than 400 Bq by total gamma measurement ^{*1}	Above 400 Bq by total gamma measurement ^{*1}
Less than detection limit (LTD)	51	8 ^{*2}	3 ^{*2}
Less than 4Bq/cm ²	0	3	12
Above 4Bq/cm ²	0	0	20

For the 35 samples with surface contamination higher than the detection limit of the GM survey meter, CLALIS could also detect the activity.

^{*1} Co-60 equivalent activity. Surface contamination density, in unit of Bq/cm², can be estimated divided by the constant surface area of 100 cm², which is the averaging unit used in the Japanese Industrial Standards.

^{*2} CLALIS gives more conservative values than the GM survey meter because it uses the total count rate and the conservative source position assumed in the Monte Carlo calculation for the calibration.