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Disposal procedure for contaminated surface of tritium handling facility in the decommissioning operation

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HIGHLIGHTS

- Surveillance of tritium contamination on tritium handling facility was performed.
- Tritium released or leaked into the facility could cause uniform contamination.
- Some of the highest tritium concentration were observed at the inside.

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ABSTRACT

For the decommissioning operation of tritium handling facility, surveillance of contamination with tritium on floor, wall and roof was performed. Significant amount of tritium contamination was detected in approximately 86% of total surface measurement points and maximally 70 mm of scraping was required to eliminate tritium contamination. In some samples for measurement of tritium depth profile, the highest tritium concentration was observed at the inside but not the surface. This measurement result of depth profile is also discussed with our previous calculation results considering diffusion, adsorption, desorption of tritium in the concrete and isotope exchange reaction between tritiated water vapor in the concrete bulk and atmospheric water vapor.

1. Introduction

After the tritium handling operation, to take an appropriate disposal method of tritium handling facility contaminated with tritium is one of the important issues to obtain the social acceptance of nuclear fusion plant. Studies on interactions between tritium and concrete buildings have been conducted for evaluation of fusion reactor accidents [1–6]. However, in the decommissioning operation after shut down of tritium handling facilities, technical reports on the establishment of suitable contamination measurement, effective decontamination and appropriate waste management are few.

This study shows the measurement, detritiation and disposal procedures of the tritium handling facility performed in the final step of the decommissioning operation. The tritium depth profile obtained from extracted concrete is also discussed comparing with our previous calculation results considering diffusion, adsorption, desorption of tritium in the concrete and isotope exchange reaction between tritiated water in the concrete and atmospheric water vapor.

2. Decommissioning procedures

In Kyushu University, for the relocation program to the new campus, decommissioning operations for the building of tritium handling facility located in the former campus had been performed since 2006. The tritium handling facility made of concrete belonging to faculty of engineering was used for the acceleration experiments with 370 GBq of tritium target per one acceleration experiment from 1961 to around 1980. However, detailed records about experimental conditions have not been left. Before the decommissioning operation of the building, the authors performed the removal of used accelerator, left experimental apparatus and articles, the elimination of tritium from vacuum pump oils etc. [7].

The decommissioning operation for the handling facility building consists of first surface measurement of contamination with

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radioisotope, detailed second measurement after the first measurement, contamination removal operation and radioactive waste disposal. In the preparatory measurement of the inner surface of the accelerator facility, other radioisotopes except tritium were not detected.

2.1. Surface measurement

Measurements of surface contamination with tritium for the inner surface of floor, four side walls and roof were performed on the bare concrete surface. The measurement for the floor surface was done after removing a linoleum sheet. In four side walls, each bottom part was excluded in this measurement because it was painted on the bare concrete and consequent surface property is different from other parts. Measurements of tritium contamination on the inner surface of the building were carried out as the following steps.

(1) Mark off the surface areas in 1 m × 1 m for floor, 2 m × 1 m for wall and 2 m × 2 m for roof.
(2) Measurement for the surface of floor, wall and roof by the smear method with filter paper. (1st measurement)
(3) Re-mark off the surface areas in 0.25 m × 0.25 m when contamination is detected in step (2).
(4) Re-measurement for the surface of floor, wall and roof by the smear method. (2nd measurement)

2.2. Detritiation procedures

When the decommissioning of radioisotope handling facility is performed in Japan, it is provided by the "Law concerning prevention from radiation hazards due to radio-isotopes, etc." that contamination with radioisotopes is not detected. Thus, a part of concrete includes contamination with tritium detected in the measurement was eliminated by scraping method. Scrapings produced by elimination were disposed as an incompressible radioactive waste. The methods of elimination for a part of contaminated concrete are as follows.

(5) Scrape off 10 mm from concrete surface when significant contamination is detected in the step (4) of Section 2.1. (1st scraping)
(6) Re-measurement for the surface of floor, wall and roof by smear method. (3rd measurement)
(7) Scrape off 30 mm from concrete surface when significant contamination is detected in the step (6). (2nd scraping)
(8) Repeat measurement and scraping until significant tritium contamination is not detected.

2.3. Depth profiles

Following the measurement of tritium concentration in the inner wall of the building, tritium measurement in the depth direction was performed to correlate with the measurement of surface concentration. Measurement procedures of the concrete depth profiles are as following steps and illustrated in Fig. 1.

(a) Arbitrarily select 4 points from the floor surface where contamination was detected and 1 point from floor surface where contamination was not detected.
(b) Extracting cylindrical concrete core samples from each selected points.
(c) Cut 1 sample into 8 pieces equally.
(d) Crush the divided piece into 5–10 mesh.
(e) Arbitrarily take 3 g of crushed concrete and soak into a scintillation cocktail.

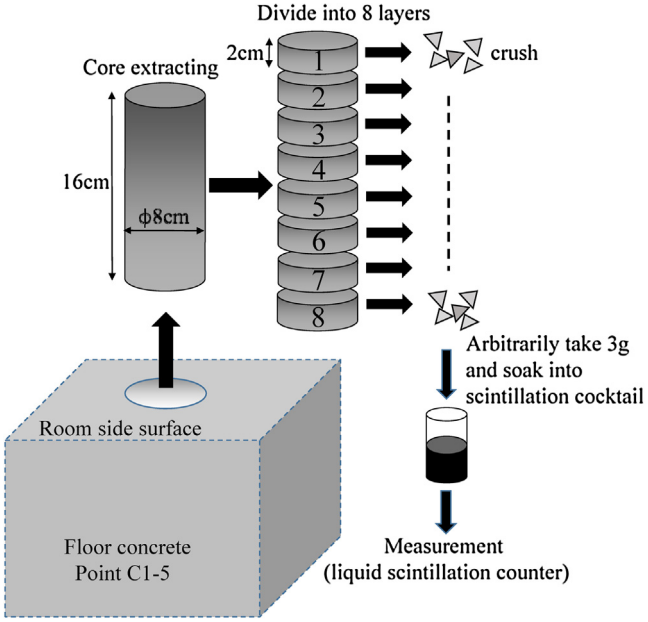

Fig. 1. Measurement procedure of concrete depth profile.

(f) Continue a measurement of tritium concentration by liquid scintillation counter until it becomes constant.

3. Results and discussions

3.1. Result of surface measurement and detritiation

In the decommissioning operation for the building of radioisotope handling facility, it is required to remove the contamination with any radioisotopes and adequate treatment of radioactive waste produced in the decommissioning operations. Table 1 shows number of measurement points and scraping ratio in the each handling steps. In the first measurement, tritium contamination at each point was not remarkably high comparing to the background but 86% of total surface smear points were being contaminated. The highest surface tritium concentration was observed at the south side wall with 38 Bq/cm^2. Accordingly, scraping to eliminate contamination of building inner surface was performed for 73% of total inner surface area. Maximally 70 mm of scraping was required to completely remove the tritium contamination. The measurement results showed that tritium released or leaked into the handling facility could cause uniform contamination of building surface.

3.2. Result of depth profile measurement

Fig. 2 shows the depth profile of tritium concentration obtained from 5 concrete core samples. Depth profile of tritium concentration obtained from core sample showed that significant tritium contamination was not detected in the inner point when tritium contamination was not detected on the surface (C5). As shown in C1 and C4, when significant tritium contamination was detected on the surface, it is generally considered that the highest contamination point exists in the point face the operation room. However, for three measurement points, the inner tritium concentration was obviously higher than the surface contamination (Layer 6 and 8 in C2, Layer 8 in C3).

The measurement results that some of the highest points existed at the inside of the wall may be considered as follows. Tritium released or leaked into the operation room penetrates into the concrete wall with a concentration gradient during the accelerator

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