

# Safety Evaluation of a NORM Site Restoration in Korea

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## 1. Introduction

There are several types of industries generating naturally occurring radioactive material (NORM) residues in Korea. Of these, the manufacture of titanium dioxide (TiO<sub>2</sub>) pigments belongs to the specific industry sectors given in IAEA SRS No.49, identified as being the most likely to require regulatory consideration. In 2016, one facility stopped the operation and completed decommissioning including site clean-up. To estimate the safety of restoration site, Korea Institute of Nuclear Safety (KINS) performed a car-borne radiation survey using NaI(Tl) detector and *in-situ* HPGe spectrometry. Based on the *in-situ* measurement results, the equivalent activity concentration distribution levels of <sup>238</sup>U, <sup>232</sup>Th, and <sup>40</sup>K before and after the restoration were evaluated.

## 2. NORM Residue Site

### 2.1 TiO<sub>2</sub> Pigment Manufacture

Titanium minerals contain basically radionuclides of natural origin in the <sup>232</sup>Th and <sup>238</sup>U decay series. The radionuclide activity concentrations are known to be moderately elevated in compared to common rocks and soil. During processing, these radionuclides may become mobilized and migrate to dusts, scales and other process residues, leading to

the possibility of radionuclide activity concentrations higher than those in the raw materials. In particular, Ra may be concentrated in the scales.

### 2.2 Site Description

The closed facility is an area of 72,727 m<sup>2</sup>, which had been operated for 47 years using a sulphate process route.

## 3. Materials and Methods

### 3.1 Radiation Measurement Equipment

All radiological surveys were performed using two survey cars equipped with the following.

- Large volume NaI(Tl) scintillation detector (4" x 4" x 16", SAINT-GOBAIN)
- Multi-Channel Analyzer (MCA, ORTEC)
- High pressure ionization chamber (HPIC, GE)
- GPS terminal
- LTE wireless communication system
- Operating software (RadSearch Co.)

### 3.2 Car-borne Survey and Evaluation Method

While a vehicle is moving at low speeds (< 10 km/h), gamma spectra, gamma dose rates and GPS signals are being continuously collected with the NAI

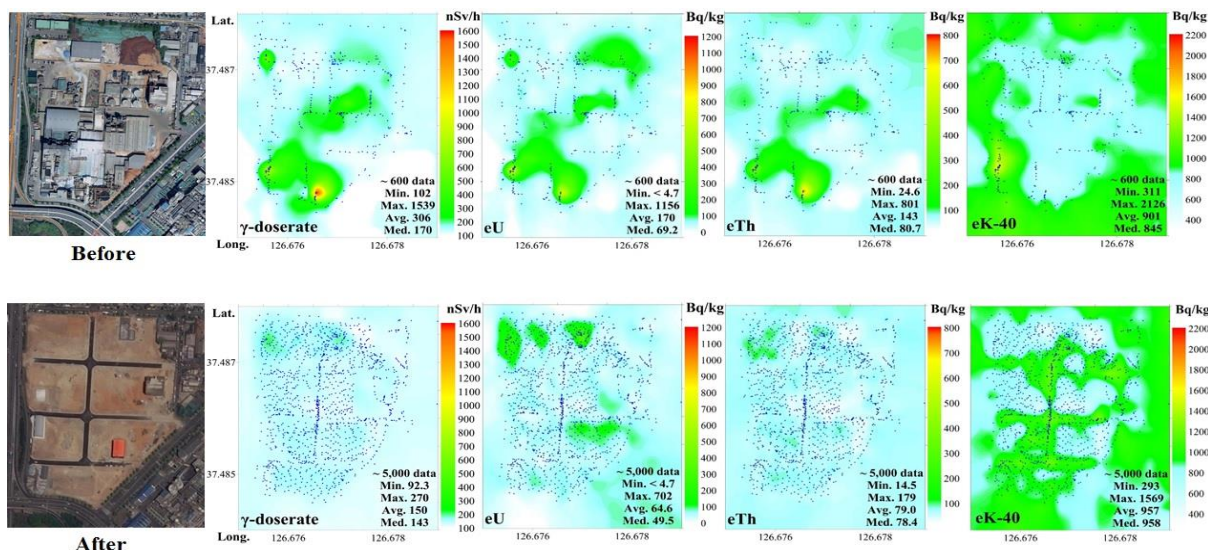


Fig. 1. The comparison of the distribution of the gamma dose rate and activity concentration before/after D&D  $\gamma$ -dose rate by HPIC and eU, eTh and eK-40 activity by NaI(Tl).

(Tl) detector, HPIC and GPS terminal, respectively.

The correlation equations between the cps and the activity concentration (Bq/kg) in surface soil for each nuclide were obtained based on the activity concentration calculated from the *in-situ* HPGe measurement. Finally, the distribution maps for each nuclide were contoured as using the Bq/kg unit with the mapping program, Surfer 13 (Golden Software LLC., USA).

#### 4. Results

The equivalent concentration of  $^{238}\text{U}$  during the decommissioning and dismantling (D&D) was 4.7 ~ 1,156 Bq/kg, which was reduced to 4.7 ~ 702 Bq/kg after the restoration. In the case of  $^{232}\text{Th}$ , the activity was 24.6 ~ 801 Bq/kg during D&D, but it was maximum 179 Bq/kg after the restoration. Additionally, the average for the gamma dose rate by HPIC was 145 nSv/h. The before and after distribution comparison of the gamma dose rate and activity concentration is represented in contour maps shown in Fig. 1.

#### 5. Conclusion

A first case for the decommissioning of NORM facility was happened in Korea. As a result of safety evaluation of the site restoration, the restoration site has no more influence on the environment.

#### REFERENCES

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