Waste characterisation in a Swedish uranium facility during decommissioning using nuclide vectors and nuclide specific measurements

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Clearing out the buildings in the decommissioning of Ranstad, a uranium facility in Sweden, had several challenges. Ranstad is classified as a nuclear facility and is operated under the same regulations as nuclear power plants. The radiological fingerprint at the site is dominated by the naturally occurring decay chains of uranium and thorium, and the activity concentration in objects is, in some cases, even below the natural occurring concentration in soil and other material. Conditional exemptions from the clearance regulation was given, but regardless of this, radiometric and logistic challenges needed to be solved.

In total more than 140 tonnes, packed in more than 1200 containers, of loose equipment or waste from the facility have so far been treated in the project. The planning phase identified the characterization of these objects as time critical for the total project. The radiometric challenges arose from poor gamma radiation yield from the important radioisotopes in the decay chains, from background interference and from complications in the measurement geometry's. The radioisotope fingerprint in the contamination is in most cases not known and can be described as a mixture of unbroken and broken chains of uranium, mixture of naturally enrichment and enrichment grade up to 3.5% Uranium-235. To be able to meet the conditional clearance criteria in a time optimised way, a combination of material sorting, gamma and beta radiation measurements and application of theoretical calculations of nuclide vectors was used.

One problematic radioisotope is for example Th-230 which has a relatively long half-life but hard to measure by gamma spectrometry in dense and volumetric large geometries. In addition, Th-230 also has a factor of 10 lower free release limit than the other isotopes in the decay chain. Specific rules were set up to determine the activity concentration based on measured detection limits and isotopic relationship in the different options of isotope relations (nuclide fingerprint).

Gamma spectrometry of U-235 and the short-lived isotopes Pa-234m and Th-234, together with specific rules for detection limit values and measured values were used to calculate the enrichment of U-235 and uranium concentration in the objects. The limit of uranium concentration was given uncorrelated to the isotope specific limits and must therefore be calculated for each object.
A very important part in the procedure for getting a better precision in the measurements was material sorting. Inhomogeneity in both material matrix and activity distribution increase the measurement uncertainties. Therefore specific rules were set up for the packing based on material type and the total gamma radiation, quickly measured with handheld detectors.

This paper will discuss lessons learned from solving a radiometric and logistic problem in a decommissioning project. Even though the special nuclide fingerprint for this project required special solutions for determination of uranium contents, the general ideas can be adopted to other projects.