Motivation

During the process of decommissioning of a nuclear power plant, large material volumes are subject to release procedure. For this purpose - among other issues - samples have to be taken and analyzed in order to gain information about surface contamination, material activation and nuclear activities of certain isotopes. One important requirement part of the release procedure is the measurement of Strontium-90 contamination.

Strontium-90

Strontium-90 is one of the most common fission products. Strontium-90 undergoes β-decay into Yttrium-90 and then into stable Zirconium-90. In both decays no gamma emission is released. The comparatively low end-point energy of the β-electrons is at 54.6 keV. The decay to Yttrium-90 impedes the detection of these particles because of the absorption in the sample material.

Under certain conditions it is possible to detect Strontium-90 contamination indirectly. The activity of Strontium-90 can be determined by shielding the proportional counter against β-emitters with lower end-point energies compared to the Yttrium-90 β-emitter. The Strontium-90/Yttrium-90 equilibrium allows the derivation of the Strontium-90 activity based on the measured Yttrium-90 activity [1][2].

Experimental

Dedicated experimental studies were done to determine the activity of Strontium-90, the associated detection limit and decision threshold in accordance with the release procedure. The following aspects have been examined:

- Optimization of the absorber thickness for shielding the detector against β-radiation from sources other than Yttrium-90
- Simplified sample preparation and further processing by a suitable easy to use detector system
- Determination of the associated detection limit and the minimum detectable activity for the selected isotopes, in particular of Strontium-90.
- Comparison of the limits with the requirements of the release procedure.

The applied measuring system was a low-level manual sample changer LB 761 Gd-fluor with anti-coincidence shielding (Berthold Technologies). For the measurements various sources - Kalium-40, Cesium-137, Cobalt-60, Strontium-90 and high-purity aluminum absorbers of varying thickness were used.

Results

- The new method Strontec ™ allows the rapid and high accurate measurement of the Strontium-90 activity using verified existing sampling equipment and analytical methods. Complex and costly sample preparations so far used in analytical radiochemical procedures are no longer required.
- The evaluation model used in the new method Strontec ™ simplifies the determination of the Strontium-90 activity, the associated detection limit and decision threshold. It was verified that the calculated and the measured activities are in good agreement.
- By optimizing the absorber thickness sufficiently low sensitivity limits an minimum detectable activities for release procedure can be achieved with the new method Strontec ™. The requirements of the release levels of Strontium-90 according to the German radiation protection ordinance can be fulfilled.
- Strontec ™ was established in cooperation with Berthold Technologies.

References


Fig. 2. Sample preparation, ready to use sample, measuring equipment [3]

Fig. 3. Log-linear plot of the count rate of Strontium-90/Yttrium-90 versus the absorber thickness with an effective measured range E_{measured}= 4.17 x 0.04 mm [3]

Fig. 4. Log-linear plot of the theoretical count rate (red) and the experimental count rate (black) of Strontium-90/Yttrium-90 [3]

Strontec ™
A new Method for the Detection of Strontium-90 Contamination