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Fission Neutron Tomography of a 280-L Waste Package

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For the non-destructive characterization of radioactive waste packages for the declaration or verification of their radioactive inventory, well-established passive and active methods are applied. These are mainly based on gamma-spectroscopic emission measurements (segmented gamma scanning), gamma-transmission measurements (e.g. radiography and tomography) using an external Co-60 source or accelerator, neutron emission counting with time correlation analysis to distinguish between neutrons originating from spontaneous fission or (alpha,n) events, respectively, and neutron interrogation techniques inducing fission events. Tomography using fission neutrons, both in transmission and emission mode, is not applied on waste packages, yet.
In a recent feasibility study [2] it was demonstrated that fission neutron radiography of 200-l (radioactive) waste drums is possible at NECTAR [1]. In a subsequent step, the study is extended on tomographic investigation of 200-l and one 280-l mock-up waste drums. The latter contained a 200-l drum with a mixture of supercompacted waste in the bottom and raw waste in the upper part. The result of this 3D-tomography is compared with the corresponding one using an external Co-60 transmission source.
In further experiments at NECTAR, the influence on the resulting images in radiographic measurements were investigated for additional strong AmBe-neutron sources being present in the waste packages. These results will give information on possible artefacts in tomographic reconstructions caused by internal neutron sources in the radioactive waste packages.
Results of these measurements will be presented and discussed. In a final conclusion, the applicability of fission neutron tomography, its specific characteristics, the limitations and a critical comparison with the well-established Co-60 gamma-transmission tomography for the non-destructive characterization of radioactive waste packages will be presented.

[1] NECTAR: Heinz Maier-Leibnitz Zentrum. (2015). NECTAR: Radiography and tomography station using fission neutrons. Journal of large-scale research facilities, 1, A19. http://dx.doi.org/10.17815/jlsrf-1-45
[2] T. Bücherl, O. Kalthoff, Ch. Lierse von Gostomski, A feasibility study on reactor based fission neutron radiography of 200-l waste packages, Physics Procedia 88 (2017) 64 – 72.

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