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Optimal decommissioning planning of NPPs using validated neutron fluence calculations

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The last nuclear power plants in Germany have been shut down in spring 2023 and are in the process of decommissioning. For this process, it is necessary to estimate the different waste quantities and qualities, e.g. between activated, contaminated and material which can be released for further use. Part of the contamination due to deposits of radioactive particles on the surface can be removed by cleaning. However, the activation of the material by neutrons cannot be removed. This activation depends on the one hand on the possibility of neutron diffusion into the surrounding rooms and subsequent penetration into the components and on the other hand on the years of operation of the plant and the power history in the cycles. Therefore, neutron fluence is a basic and important parameter in the evaluation of possible activation of materials during decommissioning and should be calculated as accurately as possible.

For the calculation of the neutron fluence characteristics in components outside the pressure vessel, a very detailed 3D Monte Carlo (MC) model of a German pressurized water reactor was developed. In addition to the exact modeling, the neutron source used in particular for the peripheral fuel assemblies is very important. This was determined pin by pin on the basis of the real burn-up calculations. Both the model and the source were validated with the aid of metal foil activation measurements, which were carried out at different locations. Metal foil activation measurements, also known as neutron fluence monitors, have been used successfully in reactor dosimetry for many years and are an ideal method for obtaining information about the neutron fluence in an operating reactor or other facilities with denitrifying neutron radiation.

This presentation gives an overview of the MC model of the reactor and presents the foil activation measurement method. The results of the MC simulations and the experimental measurements are then presented, corresponding C/E (calculation/experiment) comparisons are shown and discussed.

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