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Nuclear Safeguards Verification of Modelled Partial Defect PWR fuel using Multivariate Analysis

Multivariate analysis (MVA) is an analysis approach, whereby multiple signatures are analyzed simultaneously using algorithms capable of identifying structures in the data that are otherwise not easily identified. We have applied MVA to nuclear safeguards, by constructing a modelling tool that has the capability to analyze both passive gamma spectroscopy signatures and passive neutron signatures. Compared to traditional safeguards analysis, where a few number of gamma energies are selected and analyzed separately from the neutron signature, this approach opens up the possibility to select an arbitrary number of gamma transition lines and to relate the gamma response with the neutron response.

In this paper, spent nuclear fuel of 17x17 PWR-type with a wide range of fuel parameter values are modelled in Serpent2. The measurement responses from two passive measurement techniques are also modelled: that of a high-purity germanium detector and the Differential Die-Away Self-Interrogation (DDSI) prototype instrument. The MVA algorithm selected for the analysis is a custom-made partial least squares (PLS) regression.

The objective of the paper is twofold: i) to apply MVA to intact spent nuclear fuel in order to investigate the capability to determine initial enrichment, burnup and cooling time , ii) to apply MVA to fuels with different kinds of partial defect. Results from the simulations will be shown and the capability of using MVA for the verification of spent nuclear fuel using the described signatures will be evaluated.

Which ”Key Question” does your Abstract address?

NEW1.2

Topics

NEW1

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