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DESIGN AND VALIDATION OF A GAMMA-RAY SCANNING SYSTEM FOR MEASURING IRRADIATED NUCLEAR FUEL

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A prototype gamma-ray scanning system was designed to perform post-irradiation measurements of nuclear fuel at Idaho National Laboratory (INL). The system is composed of a coaxial high-purity germanium (HPGe) detector, a collimator, and mechanical positioning stages that translate the fuel sample across the front of the collimator. This paper documents the design process, modeling and the laboratory characterization performed to validate the system. The modeling of the system was done using the Monte Carlo N-Particle code with vendor-supplied design specifications, dimensional measurements, and x-ray radiographs of the HPGe detector. The characterization included measurements of calibrated radiation sources in different geometries, and calculations for absolute efficiency and dead time. Benchmark measurements were performed by scanning an irradiated fuel rodlet containing ten pellets of 4.9% enriched UO_2 in zirconium alloy. These results were compared to simulated spectra to further help characterize the detector model. One goal of the system is to determine the number of fissions per gram of UO_2 in the fuel; comparison of the results from this prototype system's assay of the irradiated fuel rodlet are in agreement with previously estimated results.