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Uncertainty Quantification for Safeguards Measurements

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Part of the scientific method requires all calculated and measured results to be accompanied by a description that meets user needs and provides an adequate statement of the confidence one can have in the results. The scientific art of generating quantitative uncertainty statements is closely related to the mathematical disciplines of applied statistics, sensitivity analysis, optimization, and inversion, but in the field of non-destructive assay, also often draws heavily on expert judgment based on experience. We call this process uncertainty quantification, (UQ). Philosophical approaches to UQ along with the formal tools available for UQ have advanced considerably over recent years and these advances, we feel, may be useful to include in the analysis of data gathered from safeguards instruments. This paper sets out what we hope to achieve during a three year US DOE NNSA research project recently launched to address the potential of advanced UQ to improve safeguards conclusions.

By way of illustration we discuss measurement of uranium enrichment by the enrichment meter principle (also known as the infinite thickness technique), that relies on gamma counts near the 186 keV peak directly from 235U. This method has strong foundations in fundamental physics and so we have a basis for the choice of response model - although in some implementations, peak area extraction may result in a bias when applied over a wide dynamic range. It also allows us to describe a common but usually neglected aspect of applying a calibration curve, namely the error structure in the predictors. We illustrate this using a combination of measured data and simulation.

Country or International Organization

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