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Modified Truncated Multiplicity Analysis to Improve Verification of Uranium Fuel Cycle Materials

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Accurate verification of 235U enrichment and mass in UF6 storage cylinders and the UO2F2 holdup contained in the process equipment is needed to improve international safeguards and nuclear material accountancy at uranium enrichment plants. Small UF6 cylinders (1.5”and 5”diameter) are used to store the full range of enrichments from depleted to highly-enriched UF6. For independent verification of these materials, it is essential that the 235U mass and enrichment measurements do not rely on facility operator declarations. Furthermore, in order to be deployed by IAEA inspectors to detect undeclared activities (e.g. during complementary access), it is also imperative that the measurement technique is quick, portable, and sensitive to a broad range of 235U masses. Truncated multiplicity analysis is a technique that reduces the variance in the measured count rates by only considering moments 1, 2, and 3 of the multiplicity distribution. This is especially important for reducing the uncertainty in the measured doubles and triples rates in environments with a high cosmic ray background relative to the uranium signal strength. However, we believe that the existing truncated multiplicity analysis throws away too much useful data by truncating the distribution after the third moment. This paper describes a modified truncated multiplicity analysis method that determines the optimal moment to truncate the multiplicity distribution based on the measured data. Experimental measurements of small UF6 cylinders and UO2F2 working reference materials were performed at Los Alamos National Laboratory (LANL). The data were analyzed using traditional and modified truncated multiplicity analysis to determine the optimal moment to truncate the multiplicity distribution to minimize the uncertainty in the measured count rates. The results from this analysis directly support nuclear safeguards at enrichment plants and provide a more accurate verification method for UF6 cylinders and uranium holdup in high background environments.

Country or International Organization

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