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Cost Effective Process Monitoring using UV-VIS-NIR Spectroscopy

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UV-VIS-NIR Spectroscopy is a simple and inexpensive measurement technology which has been proposed for process monitoring applications at reprocessing plants. The purpose of this work was to examine if spectroscopy could replace more costly analytical measurements to reduce the safeguards burden to the operator or inspector. Recognizing that the higher measurement uncertainty of spectroscopy makes it unsuited for the accountability tanks, the approach instead was to focus on replacing mass spectrometry for random samples that are taken in a plant. The Interim Inventory Verification and Short Inventory Verification (IIV/SIV) at the Rokkasho Reprocessing Plant utilize random sampling of internal process vessels and laboratory measurement using Isotope Dilution Mass Spectrometry (IDMS) to account for plutonium on a timely basis. These measurements are time-consuming, and the low uncertainty may not always be required. For this work, modeling was used to examine if spectroscopy could be used without adversely affecting the safeguards of the plant. The Separation and Safeguards Performance Model (SSPM), developed at Sandia National Laboratories, was utilized to examine the replacement of IDMS measurements with spectroscopy. Modeling results showed that complete replacement of IDMS with spectroscopy lowered the detection probability for diversion by an unacceptable amount. However, partial replacement (only for samples from vessels with low plutonium content) did not adversely affect the detection probability. This partial replacement covers roughly half of the twenty or so sampling points used for the IIV/SIV. A cost-benefit analysis was completed to determine the cost savings that this approach can provide based on lower equipment costs, maintenance, and reduction of analysts' time. This work envisions working with the existing sampling system and performing the spectroscopic measurements in the analytical laboratory, but future work could examine incorporating spectroscopy as a true on-line monitor that does not require sampling.

Country or International Organization

United States of America

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