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The Analysis of Measurement Errors as Outlined in GUM and in the IAEA Statistical Methodologies for Safeguards: a Comparison

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We compare the definitions and propagation of measurement errors as outlined in GUM (Guide to the expression of Uncertainty in Measurement) and in the IAEA statistical methodologies for safeguards. Measurement errors are not observable. Based on a correct mode of error propagation, we can estimate the variances of measurement errors. In order to do so, we have to first define a mathematical measurement error model. Based on this model, we can then carry out propagation of errors with the aim to determine realistic estimates of the variance of measurement errors. For illustration purposes, we use the mathematical error model describing the measurement errors associated with a linear calibration. We can demonstrate that the mathematical error model for any calibration, which always consists of a random and systematic component, is subsumed in the mathematical error model used in the IAEA statistical methodology for safeguards. The goal of this paper is to describe the mode of propagation of measurement errors as outlined in GUM and in the IAEA statistical methodology for safeguards and to compare the mathematical error model used for a linear calibration with the model used for the evaluation of paired data. Paired data are obtained by measuring the same item with two different measurement methods and are used by the IAEA to estimate the measurement error variances of plant operators and inspectors in order to inform the material balance evaluation (MBE) process. Adequate methods of error propagation are of paramount importance to draw soundly based conclusions from material balance evaluation at bulk-handling facilities.

Keywords: GUM, error propagation, material balance evaluation, linear calibration, paired data

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