The use of a Monte Carlo method for uncertainty calculation, with an application to the measurement of neutron ambient dose equivalent rate

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Abstract

This paper is concerned with the use of a Monte Carlo method for uncertainty calculation as an implementation of the propagation of distributions [1]. It reviews the basic principles of the propagation of distributions and numerical aspects of a Monte Carlo implementation. It also discusses possible advantages in some circumstances of the propagation of distributions over the GUM uncertainty framework [2], and how the results obtained in any particular instance can be compared with those provided by that framework.

To illustrate these various aspects, an application to the measurement of neutron ambient dose equivalent rate is given. A key consideration in this application is the manner in which the dominant source of uncertainty, viz., that associated with the field-specific correction factor, is treated. The information available concerning this factor is of two types: (i) the correction factors for a set of fields of the same type as that in which a measurement is being made, and (ii) expert knowledge provided by practitioners in the area. This information is encoded as a probability density function (PDF) for the correction factor. That PDF constitutes an input to both methods of evaluation.

[1] BIPM, IEC, IFCC, ILAC, ISO, IUPAC, IUPAP, and OIML. Guide to the Expression of Uncertainty in Measurement. Supplement 1—Propagation of Distributions using a Monte Carlo method, 2005. Draft.

[2] BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, and OIML. Guide to the Expression of Uncertainty in Measurement, 1995. ISBN 92-67-10188-9, Second Edition.