



Standard Practice for Establishing an Uncertainty Budget for the Chemical Analysis of Metals, Ores, and Related Materials¹

This standard is issued under the fixed designation E 2165; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice describes a model for establishing ISO 17025-compliant uncertainty budgets for the chemical analysis of metals, ores, and related materials. It is based on applying the Horwitz² function to widely accepted, diverse interlaboratory test programs, such as interlaboratory testing of standard test methods and proficiency testing programs. This function expresses the interlaboratory standard deviations that can be expected for any concentration level as competent laboratories use optimized test procedures to analyze any matrix for any analyte. It may be used to set aim uncertainties against which to plan new standard test methods and to assess the performance of existing test methods.

1.2 An optimized test procedure is one in which the final test results are at least equivalent to alternative, state-of-the-art procedures. In the analytical chemistry community, this means that calibrations are carried out, verified, and controlled such that the final test results have no systematic, detectable bias. The elimination of sources of bias is a key responsibility of any person who designs analytical test methods. Hence, an analytical test method that contains systematic, measurable sources of bias would probably not be accepted as an ASTM test method and its performance data would probably not be in compliance with the procedures described in this practice.

1.3 The uncertainty budget model described in this practice is based on the assumption that, in a normally distributed, bias-free environment, measurement uncertainty will improve by the square root of two with each removal of a significant source of variation. Conversely, it is assumed that measurement uncertainty will worsen by the same amount with each addition of a significant source of variation. Furthermore, this model assumes that the hierarchy of increasing variation in any composition-based measurement system begins with calibration and progresses through control to intralaboratory standard deviation to interlaboratory standard deviation to product sampling for conformity assessment. Therefore, aim values for

the expected uncertainties at any process step can be predicted using this model.

1.4 When using this model, the aim values generated using this model must then be validated, verified, and documented as part of the development and interlaboratory testing of any new test method, sampling practice, and product specification, as appropriate. It is also expected that each laboratory that elects to use that standard test method will generate data to show that the standard test method complies with the published uncertainties developed during interlaboratory testing of the standard test method. The principles in this practice can also be applied to the development of test methods used to determine the composition of other materials.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

- E 135 Terminology Relating to Analytical Chemistry for Metals, Ores and Related Materials³
- E 1282 Guide for Specifying the Chemical Compositions and Selecting Sampling Practices and Quantitative Analysis Methods for Metals, Ores, and Related Materials³
- E 1329 Practice for Verification and Use of Control Charts in Spectrochemical Analysis³
- E 1601 Practice for Conducting an Interlaboratory Study to Evaluate the Performance of an Analytical Method³
- E 2027 Practice for Conducting Proficiency Tests in the Chemical Analysis of Metals, Ores, and Related Materials⁴
- E 2053 Guide for Planning, Carrying Out, and Reporting Traceable Chemical Analyses of Metals, Ores, and Related Materials⁴
- E 2093 Guide for Optimizing, Controlling and Reporting Test Method Uncertainties from Multiple Workstations in the Same Laboratory Organization⁴

2.2 ISO Standards:

¹ This practice is under the jurisdiction of ASTM Committee E01 on Analytical Chemistry for Metals, Ores, and Related Materials and is the direct responsibility of Subcommittee E01.22 on Statistics and Quality Control.

Current edition approved November 10, 2001. Published January 2002.

² Horwitz, W., *Analytical Chemistry*, Vol 54, pp. 67A-76A, 1982.

³ *Annual Book of ASTM Standards*, Vol 03.05.

⁴ *Annual Book of ASTM Standards*, Vol 03.06.