



Standard Guide for Reporting Uncertainty of Test Results and Use of the Term Measurement Uncertainty in ASTM Test Methods¹

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1. Scope

1.1 This guide provides concepts necessary for understanding the term “uncertainty” when applied to a quantitative test result. Several measures of uncertainty can be applied to a given measurement result; the interpretation of some of the common forms is described.

1.2 This guide describes methods for expressing test result uncertainty and relates these to standard statistical methodology. Relationships between uncertainty and concepts of precision and bias are described.

1.3 This guide also presents concepts needed for a laboratory to identify and characterize components of method performance. Elements that an ASTM method can include to provide guidance to the user on estimating uncertainty for the method are described.

1.4 The system of units for this guide is not specified. Dimensional quantities in the guide are presented only as illustrations of calculation methods and are not binding on products or test methods treated.

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:²

- E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
- E122 Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process

¹ This guide is under the jurisdiction of ASTM Committee E11 on Quality and Statistics and is the direct responsibility of Subcommittee E11.20 on Test Method Evaluation and Quality Control.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

- E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods
- E456 Terminology Relating to Quality and Statistics
- E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
- E1402 Guide for Sampling Design
- E2554 Practice for Estimating and Monitoring the Uncertainty of Test Results of a Test Method Using Control Chart Techniques
- E2586 Practice for Calculating and Using Basic Statistics

2.2 Other Standard:

- ISO/IEC 17025 General Requirements for the Competence of Testing and Calibration Laboratories³

3. Terminology

3.1 Definitions:

- 3.1.1 Additional statistical terms are defined in Terminology E456.

3.1.2 *accepted reference value, n* —a value that serves as an agreed-upon reference for comparison, and which is derived as: (1) a theoretical or established value, based on scientific principles, (2) an assigned or certified value, based on experimental work of some national or international organization, or (3) a consensus or certified value, based on collaborative experimental work under the auspices of a scientific or engineering group. **E177**

3.1.3 *error of result, n* —a test result minus the accepted reference value of the characteristic.

3.1.4 *expanded uncertainty, U, n* —uncertainty reported as a multiple of the standard uncertainty.

3.1.5 *random error of result, n* —a component of the error that, in the course of a number of test results for the same characteristic, varies in an unpredictable way.

3.1.5.1 *Discussion*—Uncertainty due to random error can be reduced by averaging multiple test results.

3.1.6 *sensitivity coefficient, n* —differential effect of the change in a factor on the test result.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.