



# Standard Guide for Preparing and Interpreting Precision and Bias Statements in Test Method Standards Used in the Nuclear Industry<sup>1</sup>

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## INTRODUCTION

Test method standards are required to contain precision and bias statements. This guide contains a glossary that explains various terms that often appear in these statements as well as an example illustrating such statements for a specific set of data. Precision and bias statements are shown to vary according to the conditions under which the data were collected. This guide emphasizes that the error model (an algebraic expression that describes how the various sources of variation affect the measurement) is an important consideration in the formation of precision and bias statements.

### 1. Scope

1.1 This guide covers terminology useful for the preparation and interpretation of precision and bias statements.

1.2 In formulating precision and bias statements, it is important to understand the statistical concepts involved and to identify the major sources of variation that affect results. Appendix X1 provides a brief summary of these concepts.

1.3 To illustrate the statistical concepts and to demonstrate some sources of variation, a hypothetical data set has been analyzed in Appendix X2. Reference to this example is made throughout this guide.

1.4 It is difficult and at times impossible to ship nuclear materials for interlaboratory testing. Thus, precision statements for test methods relating to nuclear materials will ordinarily reflect only within-laboratory variation.

### 2. Referenced Documents

#### 2.1 ASTM Standards:

E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods<sup>2</sup>

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method<sup>2</sup>

#### 2.2 ANSI Standard:

ANSI N15.5 Statistical Terminology and Notation for Nuclear Materials Management<sup>3</sup>

### 3. Terminology for Precision and Bias Statements

#### 3.1 Definitions:

<sup>1</sup> This guide is under the jurisdiction of ASTM Committee C-26 on Nuclear Fuel Cycle and is the direct responsibility of Subcommittee C26.06 on Statistical Applications.

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 14.02.

<sup>3</sup> American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

3.1.1 *accuracy* (see *bias*)—(1) bias. ( 2) the closeness of a measured value to the true value. ( 3) the closeness of a measured value to an accepted reference or standard value.

3.1.1.1 *Discussion*—For many investigators, accuracy is attained only if a procedure is both precise and unbiased (see *bias*). Because this blending of precision into accuracy can result occasionally in incorrect analyses and unclear statements of results, ASTM requires statement on bias instead of accuracy.<sup>4</sup>

3.1.2 *analysis of variance (ANOVA)*—the body of statistical theory, methods, and practices in which the variation in a set of data is partitioned into identifiable sources of variation. Sources of variation may include analysts, instruments, samples, and laboratories. To use the analysis of variance, the data collection method must be carefully designed based on a model that includes all the sources of variation of interest. (See Example, Appendix X2.1.1)

3.1.3 *bias* (see *accuracy*)—a constant positive or negative deviation of the method average from the correct value or accepted reference value.

3.1.3.1 *Discussion*—Bias represents a constant error as opposed to a *random error*.

(a) A method bias can be estimated by the difference (or relative difference) between a measured average and an accepted standard or reference value. The data from which the estimate is obtained should be statistically analyzed to establish bias in the presence of random error. A thorough bias investigation of a measurement procedure requires a statistically designed experiment to repeatedly measure, under essentially the same conditions, a set of standards or reference materials of known value that cover the range of application. Bias often varies with the range of application and should be reported accordingly.

<sup>4</sup> Refer to *Form and Style for ASTM Standards*, 8th Ed., 1989, ASTM.

