



## Standard Practice for Statements on Precision and Bias for Textiles<sup>1</sup>

This standard is issued under the fixed designation D 2906; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### INTRODUCTION

Work was begun in August 1966 on recommendations for statements on precision and accuracy. The first recommendations were issued as ASTMD-13 White Paper, Statements on Precision and Accuracy, MARK I, December 1968, prepared by Subcommittee C-6 on Editorial Policy and Review. After a decision that the recommendations should be a recommended practice under the responsibility of Subcommittee D13.93, Sampling, Presentation and Interpretation of Data, the recommendations were revised and published as Practice D 2906 – 70 T.

Information was added in Practice D 2906 – 73 on methods (1) for which precision has not been established, (2) for which test results are not variables, and (3) for which statements are based on another method. Practice D 2906 – 74 was expanded to include test methods in which test results are based on the number of successes or failures in a specified number of observations or on the number of defects or instances counted in a specified interval of time or in a specified amount of material. The present text provides for a nontechnical summary at the beginning of recommended texts based on normal distributions or on transformed data and for a more positive statement on accuracy when the true value of a property can be defined only in terms of a test method.

In 1984, changes were introduced to replace the term “accuracy” with “bias” as directed in the May 1983 edition of *Form and Style for ASTM Standards*.

### 1. Scope

1.1 This practice serves as a guide for using the information obtained as directed in Practice D 2904 or obtained by other statistical techniques from other distributions, to prepare statements on precision and bias in ASTM methods prepared by Committee D-13. The manual on form and style for standards specifies that statements on precision and bias be included in test methods.<sup>2</sup> Committee D-13 recommends at least a statement about single-operator precision in any new test method, or any test method not containing a precision statement that is put forward for 5-year approval, in both instances with a complete statement at the next reapproval. If a provisional test method is proposed, at least a statement on single-operator precision is expected.

1.2 The preparation of statements on precision and bias requires a general knowledge of statistical principles including

the use of components of variance estimated from an analysis of variance. Instructions covering such calculations are available in Practice D 2904 or in any standard text (**1,2,3,4**, and **5**).<sup>3</sup>

1.3 The instructions in this practice are specifically applicable to test methods in which test results are based (1) on the measurement of variables, (2) on the number of successes or failures in the specified number of observations, (3) on the number of defects or incidents counted in a specified interval or in a specified amount of material, and (4) on the presence or absence of an attribute in a test result (a go, no-go test). Instructions are also included for methods of test for which precision has not yet been estimated or for which precision and accuracy have been reported in another method of test. For observations based on the measurement of variables, the instructions of this practice specifically apply to test results that are the arithmetic average of individual observations. With qualified assistance, the same general principles can be applied to test results that are based on other functions of the data such as standard deviations.

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.93 on Statistics.

Current edition approved Nov. 10, 1997. Published August 1998. Originally published as D 2906 – 70 T. Last previous edition D 2906 – 91.

<sup>2</sup> *Form and Style for ASTM Standards*, May 1983, available from American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428.

<sup>3</sup> The boldface numbers in parentheses refer to the list of references at the end of this practice.

## 1.4 This standard includes the following sections:

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| Binomial Distributions, Statements Based on                            | 13          |
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| Sources of Data                                                        | 6           |
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| Significance and Use                                                   | 4           |

## 2. Referenced Documents

### 2.1 ASTM Standards:

- D 123 Terminology Relating to Textiles<sup>4</sup>
- D 2904 Practice for Interlaboratory Testing of a Textile Test Method that Produces Normally Distributed Data<sup>4</sup>
- D 2905 Practice for Statements on Number of Specimens for Textiles<sup>4,5</sup>
- E 456 Terminology Relating to Quality and Statistics<sup>6</sup>
- E 691 Practice for Conducting An Interlaboratory Study to Determine the Precision of a Test Method<sup>6</sup>

### 2.2 ASTM Adjuncts:

TEX-PAC<sup>7</sup>

NOTE 1—Tex-Pac is a group of PC programs on floppy disks, available through ASTM Headquarters, 100 Barr Harbor Drive, West Conshohocken, PA 19428, USA. The calculations of critical differences and confidence limits described in the various sections of this practice can be performed using some of the programs in this adjunct.

## 3. Terminology

### 3.1 Definitions:

3.1.1 *accuracy, n*—of a test method, the degree of agreement between the true value of the property being tested (or accepted standard value) and the average of many observations made according to the test method, preferably by many observers. See also *bias* and *precision*.

3.1.1.1 *Discussion*—Increased accuracy for a test method is associated with decreased bias relative to an accepted reference value. Although the total bias of a test method is equivalent to the accuracy of the test method, the present edition of *Form and Style for ASTM Standards* recommends using the term “bias” since the accuracy of individual observed values is sometimes defined as involving both the precision and the bias of the method.

3.1.2 *bias, n*—in statistics, a constant or systematic error in test results.

3.1.2.1 *Discussion*—Bias can exist between the true value and a test result obtained from one method, between test results obtained from two methods, or between two test results

obtained from a single method, for example, between operators or between laboratories.

3.1.3 *characteristic, n*—a property of items in a sample or population which, when measured, counted, or otherwise observed, helps to distinguish between the items. (E 456)

3.1.4 *confidence level, n*—the stated proportion of times the confidence interval is expected to include the population parameter. (E 206)

3.1.4.1 *Discussion*—Statisticians generally accept that, in the absence of special considerations, 0.95 or 95 % is a realistic confidence level. If the consequences of not including the unknown parameter in the confidence interval would be grave, then a higher confidence level might be considered which would lengthen the reported confidence interval. If the consequences of not including the unknown parameter in the confidence interval are of less than usual concern, then a lower confidence level might be considered which would shorten the reported confidence interval.

3.1.5 *critical difference, n*—the observed difference between two test results which should be considered significant at the specified probability level.

3.1.5.1 *Discussion*—The critical difference is not equal to the expected variation in a large number of averages of observed values; it is limited to the expected difference between only two such averages and is based on the standard error for the difference between two averages and not on the standard error of single averages.

3.1.6 *laboratory sample, n*—a portion of material taken to represent the lot sample, or the original material, and used in the laboratory as a source of test specimens.

3.1.7 *lot sample, n*—one or more shipping units taken at random to represent an acceptance sampling lot and used as a source of laboratory samples.

3.1.8 *parameter, n*—in statistics, a variable that describes a characteristic of a population or mathematical model.

3.1.9 *percentage point, n*—a difference of 1 percent of a base quantity.

3.1.9.1 *Discussion*—A phrase such as “a difference of X %” is ambiguous when referring to a difference in percentages. For example, a change in the moisture regain of a material from 5 % to 7 % could be reported as an increase of 40 % of the initial moisture regain or as an increase of two percentage points. The latter wording is recommended.

3.1.10 *precision, n*—the degree of agreement within a set of observations or test results obtained as directed in a method.

3.1.10.1 *Discussion*—The term “precision”, delimited in various ways, is used to describe different aspects of precision. This usage was chosen in preference to the use of “repeatability” and “reproducibility” which have been assigned conflicting meanings by various authors and standardizing bodies.

3.1.11 *precision, n*—under conditions of single-operator precision, the single-operator-laboratory-sample-apparatus-day precision of a method; the precision of a set of statistically independent observations all obtained as directed in the method and obtained over the shortest practical time interval in one laboratory by a single operator using one apparatus and randomly drawn specimens from one sample of the material being tested.

<sup>4</sup> Annual Book of ASTM Standards, Vol 07.01.

<sup>5</sup> Annual Book of ASTM Standards, Vol 07.02.

<sup>6</sup> Annual Book of ASTM Standards, Vol 14.02.

<sup>7</sup> PC programs on floppy disks are available through ASTM. Request ADJD2906.