A21. Precision and Bias (Mandatory)

A21.1 *Definitions and Additional Information*:

A21.1.1 For precise definitions of statistical terms, refer to ASTM Terminology E 456, Relating to Statistics (Vol 14.02).

A21.1.2 For more information on calculation methods relating to the use of statistical procedures, refer to ASTM Practices E 177 and E 691 (Vol 14.02).

A21.2 *Statement of Precision (Mandatory)*:

A21.2.1 Precision is the closeness of agreement between test results obtained under prescribed conditions. A statement on precision allows potential users of the test method to assess in general terms its usefulness in proposed applications. A statement on precision is not intended to contain values that can be duplicated in every user's laboratory. Instead the statement provides guidelines as to the kind of variability that can be expected between test results when the test method is used in one or more reasonably competent laboratories.

A21.2.2 Every test method shall contain a statement *(1)* regarding the precision of test results obtained in the same laboratory under specifically defined conditions of within-laboratory variability (repeatability conditions), and *(2)* regarding the precision of test results obtained in different laboratories (reproducibility conditions). Use a statement such as the following:

> Precision[1]—The repeatability standard deviation has been determined to be (insert the test values and corresponding repeatability values). The reproducibility standard deviation has been determined to be (insert test values and corresponding reproducibility values).

A21.2.3 If the responsible committee decides that an interlaboratory study should be delayed, a temporary statement shall be included which addresses only repeatability. This statement is permitted for five years.

> Precision[2]—The repeatability standard deviation has been determined to be (insert the test values and corresponding repeatability values). The reproducibility of this test method is being determined and will be available on or before (date).

[2] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RRxx.xxxx.

A21.2.4 The repeatability conditions defined in Terminology E 456 shall be used; namely, within-laboratory conditions under which test results are obtained with the same test method in the same laboratory by the same operator with the same equipment in the shortest practicable period of time using test specimens taken at random from a single quantity of homogenous material. If some other within-laboratory variability is also determined (such as for longer times or different operators within a laboratory), the particular conditions shall be reported in detail, and the precision designated "intermediate precision" (see Terminology E 456). If the committee formerly called this repeatability, add "(formerly called repeatability)."

A21.2.5 The precision statement shall include the repeatability and reproducibility standard deviation and the 95 % repeatability and reproducibility limits on the difference between two test results. The latter are numerically equal to 2.8 times the respective standard deviation for data that are known to be normally distributed, and approximately so for most other data encountered in ASTM committee work.

A21.2.6 The statement regarding between-laboratory variability shall pertain to test results obtained in different laboratories on random test units from the same lot of homogeneous material.

A21.2.7 Precision shall be estimated in accordance with the interlaboratory test program prescribed in ASTM Practice E 691, for Conducting an Interlaboratory Study to Determine the Precision of a Test Method (Vol 14.02) or by an interlaboratory test program that yields equivalent information, for example, a standard practice developed by an ASTM technical committee.

A21.3 *Statement on Bias (Mandatory)*:

A21.3.1 Bias is a systematic error that contributes to the difference between the mean of a large number of test results and an accepted reference value. A discussion on bias may be found in statistical documents, such as Practices E 177 and C 670.

A21.3.2 The bias statement shall describe the bias and methods employed to provide corrected test results. If the bias is not known but the direction or bounds on the bias, or both, can be estimated, these shall be reported in the bias statement.

A21.4 *General Considerations*:

A21.4.1 The precision and bias section of the test method shall include a brief descriptive summary of the experiments that will permit the user of the test method to judge the reliability of the data. This summary should include number of participants, number of samples, range of sample properties tested, range of sample types and instruments used where appropriate.

Note: Some or all of the elements of the description may not be readily available for standards published prior to 2000 and in these cases is not required.

A21.4.2 If precision or bias, or both, varies with the test level, the variation shall be described in the statement.

A21.4.3 The data and details of the experiments to determine precision and bias shall be filed as a research report at ASTM International Headquarters.

A21.4.4 The precision and bias statements shall include reference numbers to these files.

A21.5 *Exceptions*:

A21.5.1 When a test method specifies that a test result is a nonnumerical report of success or failure or other categorization or classification based on criteria specified in the procedure, use a statement on precision and bias such as the following:

Precision and Bias—No information is presented about either the precision or bias of Test Method X 0000 for measuring (insert here the name of the property) since the test result is nonquantitative.

A21.5.1 When a test method specifies that the procedure in another ASTM test method is to be used without modification, no statements of precision and bias are necessary if those in the other test method are applicable. When a test method specifies that the procedure in another ASTM test method is to be used with only insignificant modification(s), use a statement such as the following to assure the reader that precision and bias are not affected by the modification(s):

Precision and Bias—The precision and bias of this test method for measuring (insert here the name of the property) are essentially as specified in Test Method (insert here the designation of the other test method).

When a test method specifies that the procedure in another ASTM test method is to be used with significant revisions, present statements on precision and bias as directed in A21.2 and A21.3.

A21.5.3 If it is not feasible to determine the reproducibility, as directed in A21.2, within five years of the first approval of the standard, use a statement such as the following

Precision—The precision of the procedure in Test Method X 0000 for measuring (insert here the name of the property) is being determined and will be available on or before (month, year). It is not feasible to specify the precision of the procedure at this time because (insert here the reason or reasons).

A21.5.4 If it is not possible to provide a statement on precision as directed in A21.2, use a statement such as the following:

Precision—It is not possible to specify the precision of the procedure in Test Method X 0000 for measuring (insert here the name of the property) because (insert here the reason or reasons).

Citing impracticability is not warranted if the reason is that an interlaboratory test has revealed that the precision is poor or that the standard was written before precision statements were required.

A21.5.5 If bias cannot be determined, a statement to this effect shall be included, such as the following:

Bias—No information can be presented on the bias of the procedure in Test Method X 0000 for measuring (insert here the name of the property) because (insert here the reason; such as “no material having an accepted reference value is available”).