Designation: E2480 – 12 (Reapproved 2022)

Standard Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method with Multi-Valued Measurands[1]

This standard is issued under the fixed designation E2480; 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 the techniques for planning, conducting, and analyzing the results of an interlaboratory study (ILS) conducted for certain test methods within Committee E12.

1.2 This practice does not concern itself with the development of the test method but rather with the gathering of the information needed for the precision and bias statement after the completion of development of the test method. The data obtained in the ILS may indicate, however, that further effort is needed to improve the test method.

1.3 This practice is concerned exclusively with test methods that derive a multi-valued measurand, such as, but not limited to, spectral reflectance, transmittance function, tristimulus values, or RGB values. Variation in measurements of such multi-valued measurands are usually analyzed by reducing the data to a single-valued parameter, such as color difference, ΔE.

1.4 This practice covers methods of dealing with the non-normal distribution of the variation of sets of color-differences. This is done so that the user may derive valid statistics from such non-normal distributions.

1.5 This practice does not cover test methods, even in Committee E12, whose measurands are single-valued, or whose variations are known to be normally distributed. Task groups involved with such test methods are referred to Practice E691 which contains preferable methods of analyzing data with those properties.

1.6 This practice is not intended to establish a method for estimating possible color-difference tolerances.

1.7 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.8 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.9 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E284 Terminology of Appearance

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

E1345 Practice for Reducing the Effect of Variability of Color Measurement by Use of Multiple Measurements

3. Terminology

3.1 *Definitions*—For color and appearance terms, see Terminology E284.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *precision and bias, n*—when a test method is applied to a large number of specimens that are as nearly alike as possible, the test results obtained nevertheless will not all have the same values. A measure of the degree of agreement among these test results describes the precision of the test method for that material. This practice is designed only to estimate the precision of a test method. However, when accepted reference values are known for the materials being tested, the test result data obtained in accordance with this practice may be used to estimate the bias of the test method. For a discussion of bias estimation, see Practice E177.

3.2.2 *repeatability and reproducibility, n*—the term repeatability concerns the variability between independent test results

[1] This practice is under the jurisdiction of ASTM Committee E12 on Color and Appearance and is the direct responsibility of Subcommittee E12.02 on Spectrophotometry and Colorimetry.

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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.

obtained within a single laboratory in the shortest practical period of time by a single operator applying the test method with a specific set of test apparatus using test specimens taken at random from a single quantity of homogeneous material obtained, or prepared, for the ILS. The term reproducibility concerns the variability between single test results obtained in different laboratories, each by a different operator, each of whom has applied the test method to specimens taken at random from a single quantity of homogeneous material obtained, or prepared, for the ILS.

3.2.2.1 *Discussion*—The above single operator and single apparatus requirement, as specified in 3.2.2, means that for a particular step in the measurement process the same combination of operator and apparatus is used to obtain every test result on every specimen. Thus, one operator could prepare and mount the specimen, another actuate the measurements, and still another record the value of the result.

3.2.2.2 *Discussion*—The shortest practical period of time means that the test results are obtained in a time not less than normal testing and not so long as to permit significant changes in material, equipment, calibration, or environment.

3.2.2.3 *Discussion*—The requirement that the measurements be independent means that a single test determination begins with the mounting of the specimen on the sample port or in the transmission compartment, and ends with the removal of the test specimen from the port or compartment. All measurements are made with replacement.

3.2.2.4 *Discussion*—The requirement for different laboratories does not exclude the case where more than one instrument resides in the same company, laboratory, or room, provided that each has an independent and separate calibration traceability path from each other.

3.2.3 *test method and protocol, n*—in this practice, the term test method applies to both the actual measurement process and the written description of the process, while the term protocol refers to the written instructions given the participants for conducting the ILS.

3.2.4 *test specimens, n*—the portion of the material being tested needed for obtaining a single test determination is called a test specimen. A single test specimen may be measured more than once and the results combined to produce a test result if the protocol or test method so specifies.

4. Summary of Practice

4.1 The procedure presented in this practice consists of three steps: planning the interlaboratory study, guiding the testing phase of the study, and analyzing the test result data. The analysis includes the calculation of the numerical measures of precision of the test method applying to both within-laboratory repeatability and between-laboratory reproducibility.

5. Significance and Use

5.1 ASTM regulations require precision statements for all test methods in terms of repeatability and reproducibility. This practice may be used in obtaining the information needed to prepare a precision statement in accordance with Practice E177 and the "Blue Book."

PLANNING THE INTERLABORATORY STUDY (ILS)

6. ILS Membership

6.1 *Task Group*—Either the task group that developed the test method or a special task group formed specifically for the purpose must have overall responsibility for the funding, staffing, design, and decision-making with regard to data in the ILS. The task group should decide on the number of laboratories, materials, and test results for the ILS. The task group should obtain a statement of willingness to participate from each of the participating laboratories. In addition, the task group should obtain, randomize, and distribute the specimens to be tested.

6.2 *ILS Coordinator*—The task group must appoint one individual to act as overall coordinator of the ILS. This person has responsibility for distributing the materials and protocols to the laboratories, and for receiving the test result reports from the laboratories.

6.3 *Statistician:*

6.3.1 The test method task group should obtain the assistance of a person familiar with the statistical procedures of this practice and with the materials being tested. When no such person is available, the task group should obtain the assistance of a statistician who has experience in practical work with data from materials. Task group members need not be members of ASTM.

6.3.2 The calculation of the statistics for each material may be readily done by persons not having knowledge of statistics, but having basic knowledge of calculating and computers.

6.4 *Laboratory ILS Supervisor*—Each participating laboratory must have an ILS supervisor to oversee the conduct of the ILS within the laboratory and to communicate with the ILS Coordinator. This supervisor's name should be obtained at the time that the laboratory states its willingness to participate.

7. Basic Design

7.1 Keep the design as simple as possible in order to obtain estimates of within- and between-laboratory variability that are free of secondary effects. The basic design is represented by a two-way classification table, in which the rows represent the laboratories, and the columns represent the materials, and each cell (the intersection of a row and a column) contains a test result made by a particular laboratory on a particular material.

8. Test Method

8.1 A written version of the test method (but not one necessarily as yet published as an ASTM standard) must have been developed and be distributed with the protocol if otherwise unavailable to the participating laboratories.

8.2 The test method should have been subjected to a screening procedure, in order that some experience with the test method has been obtained before an ILS is conducted. Test conditions that affect the test results, if any, should be identified and a statement of the needed degree of control of these conditions should be provided. In addition, the test method, or the protocol, should specify to how many digits of precision each test result is to be measured.