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Standard Guide for Proficiency Test Program for Fabrics[1]

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INTRODUCTION

Proficiency testing is the use of interlaboratory test comparisons to determine the performance of individual laboratories for specific tests and to monitor the consistency and comparability of a laboratory's test data.

Participation in proficiency testing programs provides laboratories with an objective means of assessing and demonstrating the reliability of the data they are producing. Although there are several types of proficiency testing programs, they all share the common feature of the comparison of test results obtained by two or more laboratories.

One of the main uses of proficiency testing programs is to assess laboratories' ability to perform tests competently. This will involve the preparation of the test specimens, calibrating or validating the testing equipment, performing the tests and reporting the data.

Bodies assessing the technical competence of testing laboratories normally require or expect satisfactory participation in proficiency testing as evidence of a laboratory's ability to produce reliable test results.

1. Scope

1.1 This guide outlines the Proficiency Test Program for Fabrics. Elements for planning the proficiency test program, selecting the sample fabrics to be used, the testing protocol, and the calculations for the data to be reported are included in this practice.

1.2 The planning of the proficiency test program requires a general knowledge of testing of textile fabrics and statistical principles included in the analysis of the data.

1.3 This guide is designed to meet the quality systems proficiency and competence requirements of participating laboratories. This program is not accredited to any international standard.

1.4 The instructions in this guide follow the logic of full scale laboratory tests as described in Practice D 2904 and Guide E 1301, except with this new guide placing its emphasis on proficiency testing.

1.5 Procedures given in this guide are applicable to methods based on the measurement of discrete measurement data and grades or scores.

2. Referenced Documents

2.1 *ASTM Standards:*

D 123 Terminology Relating to Textiles[2]

D 737 Test Method for Air Permeability of Textile Fabrics[2]

D 1230 Flammability of Apparel Fabrics, 16CFR 1610[2]

D 2261 Test Method for Tearing Strength of Fabrics by the Tongue (Single Rip) Procedure Constraint Rate of Extension (CRE) Tensile Testing Machine[2]

D 2904 Practice for Interlaboratory Testing of Textiles that Produces Normally Distributed Data[2]

D 2906 Statements on Precision and Bias for Textiles[2]

D 3775 Test Method for Fabric Count of Woven Fabric[2]

D 5034 Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)[3]

D 5035 Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)[3]

D 6545 Flammability of Textiles Used in Children's Sleepwear[3]

E 1301 Guide for Proficiency Testing by Interlaboratory Comparisons[4]

3. Terminology

3.1 For definitions of textile and statistical terms used in this practice, and discussions of their use, refer to Terminology D 123 and appropriate textbooks on statistics.

3.2 *Definitions*—The relevant definitions are from Terminology D 123, and are the most relevant and applicable being quoted for the purposes of this practice.

3.2.1 *accuracy, n—of a test method*, the degree of agreement between the true value of the property being tested (or

[1] This guide is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.93 on Statistics.

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[2] *Annual Book of ASTM Standards,*Vol 07.01.

[3] *Annual Book of ASTM Standards,*Vol 07.02.

[4] *Annual Book of ASTM Standards,* Vol 14.02.

accepted standard value) and the average of many observations made according to the test method, preferably by many observers. **D 2906**

3.2.2 *batch sample*, *n*—the material(s) used for the proficiency test study taken from a common roll or garment lot and distributed to the participants.

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

3.2.4 *calibrate*, *n*—to determine and record the relationship between a set of standard units of measure and the output of an instrument or test procedure.

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

3.2.5.1 *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."

3.2.6 *precision*, *n—under conditions of between-laboratory precision*, the multi-laboratory single sample, single operator-apparatus-day (within laboratory) precision of a method; the precision of a set of statistically independent test results all of which are obtained by testing the same sample of material and each of which is obtained in a different laboratory by one operator using one apparatus to obtain the same number of observations by testing randomly drawn specimens over the shortest practical time interval. For a more detailed definition, refer to D 2906.

3.2.7 *proficiency testing*, *n*—determination of the laboratory testing performance by means of interlaboratory comparisons.

3.2.8 *program coordinator*, *n*—the person(s) responsible for management of all logistical issues, data collection, and report preparation.

3.2.9 *repeatability*, *n—in statistics*, the distribution of several measurements on the same part by one operator with the same gage.

3.2.10 *reproducibility*, *n—in statistics*, the distribution of several measurements on the same part by several operators with the same gage.

3.2.11 *sample*, *n*—(*1*) a portion of material which is taken for testing or record purposes. (*2*) a group of specimens used, or of observations made, which provide information that can be used for making statistical inferences about the population(s) from which the specimens are drawn.

3.2.12 *specimen*, *n*—a specific portion of a material or a laboratory sample upon which a test is performed or which is selected for that purpose.

3.2.13 *test result*, *n*—a value obtained by applying a given test method, expressed as a single determination or a specified combination of a number of determinations.

3.2.14 *testing laboratory*, *n*—laboratory that performs tests (including calibration) (also referred to as "participating laboratory," or just "laboratory").

4. Significance and Use

4.1 Proficiency testing is a means of securing estimates of the variability of results obtained by different laboratories testing homogeneous materials taken from batch samples when following procedures prescribed in a specific test method.

4.1.1 For the purpose of this guide, homogeneous materials are considered to be laboratory samples cut from the same batch sample (roll or garment lot) and selected at random for the participant laboratories.

4.2 This proficiency test program is to be considered a full-scale interlaboratory test, in which a reasonably large number of laboratories participate by testing a series of materials using one or more operators per laboratory and report the data for analysis.

4.2.1 For the purposes of this guide, Full Scale Laboratory Test is defined in Practice D 2904. This is not to be confused with the full scale testing terminology and definitions which appear in other test methods, such as flammability, that describe the size of the specimens being tested.

4.3 The statistical data generated by this practice provide information needed to exhibit participation in a formal proficiency test study.

4.4 All data are submitted to the program coordinator at ASTM Headquarters for the preparation and distribution of the proficiency testing program reports. All laboratory data are confidential with no disclosure of lab identity except for each participant's own laboratory. Published reports contain all laboratory test data (coded), statistical analysis of test data, charts plotting test results versus lab code, and other information.

5. Materials to be Used in Study

5.1 *Mechanical Testing Program*—Three types of materials are to be included in the study. The materials shall be described as light, medium and heavy as defined by the breaking strengths. The materials to be used for this study shall be selected by the Subcommittee D13.93 with assistance from participant laboratories and pertinent subcommittees. An accredited laboratory selected by the Subcommittee D13.93 shall act as host and maintain these materials. The host laboratory shall not be held responsible for the performance of the test materials at the participant laboratories.

5.2 *Flammability Test Program*—At least seven types of fabrics are to be available for the study, not all of which will be used at the same time. The materials shall be described by fiber type, construction type (woven, knit, nonwoven), surface characteristics and fabric weight as defined by the flammability characteristics. The fabrics to be used for this study shall be selected by the Subcommittee D13.93. An accredited laboratory selected by the Subcommittee D13.93 shall act as the host and maintain these fabrics. The host laboratory shall not be held responsible for the performance of the materials at the participant laboratories.

6. Distribution of Test Materials

6.1 The proficiency test program is designed for the test materials to be distributed at a minimum two times each calendar year—February and August. Each participating laboratory shall apply through ASTM Headquarters for inclusion in the program.

6.2 The materials will be distributed by having the host laboratory cut fabric samples from each batch roll or garment lot. The samples will be identified, labeled and mailed to each participating laboratory. ASTM Headquarters will provide

detailed instruction sheets and mailing labels to the host laboratory.

6.3 Instructions for testing, recording data and return; forms and fabric samples will be mailed together as instructed.

7. Selection of Test Methods

7.1 *For Mechanical Testing*—The test methods shall be selected and monitored by the Subcommittee D13.93. The protocol of this guide may not include the entire scope of methods used for testing fabric, but will include at least one mechanical test from the fields used to define woven fabric properties such as construction, air permeability and strength. Other methods may be added or deleted as directed by D13.93 with input from ASTM staff, participating laboratories, and pertinent Sub-Committee.

7.1.1 The methods to be used for this guide are as follows:

D 737 Air Permeability of Textile Fabrics
D 2261 Tearing Strength By Tongue Method (CRE Type Instrument)
D 3775 Fabric Count of Woven Fabric
D 5034 Breaking Strength and Elongation of Textile Fabrics (Grab Test)
D 5035 Breaking Strength and Elongation of Textile Fabrics (Strip Test)

7.2 *For Flammability Testing*—The test methods shall be selected and monitored by the subcommittee D13.93. The protocol of this guide may not include the entire scope of methods used for testing fabrics, but will include at least one flammability test from the fields used to define characteristics of the end use product.

NOTE 1—D13.52 is preparing two additional testing protocols to be used in conjunction with the flammability tests. The criteria are being established for lab personnel to identify the types of product being tested and a comprehensive exam for the scope of testing.

7.2.1 The methods to be used for this guide are as follows:

D 1230 Flammability of Apparel Fabrics
D 6545 Flammability of Textiles Used in Children's Sleepwear

8. Sampling

8.1 *Sampling of Materials*—The host laboratory shall allocate enough material to provide for all participating laboratories to perform the complete scope of testing for the program.

8.2 *Numbers of Determinations*—Each participating lab shall prepare the test specimens and number of determinations (replicates) as directed by the proficiency testing program.

9. Data Reporting

9.1 All data shall be reported as instructed using the forms supplied with the material package.

9.2 *Outlying Observations*—All data shall be reported. Exceptions to this general policy should be made only when assignable causes for deletion of a test value are present. In cases where there is no assignable cause for a test value being out of line, the test value shall be retained and reported.

10. Report

10.1 Table of Results pages provides a listing of laboratories with corresponding test results. Each laboratory is identified by a randomly selected code with the same laboratory code applying throughout the entire report. To maintain confidentiality of test data, the identification of lab codes will not be released from ASTM. Therefore, program participants will be able to identify only their own test data. The laboratory identification code may change with subsequent reports. Each table page contains a heading identifying the method and test fabric.

10.2 Lab Average column contains the lab average as reported to ASTM by the participating laboratories.

10.3 The Lab Range column represents the difference between the lab's lowest and highest of the raw data results.

10.4 *Description of Z-Score Column*—The Z-Score column (comparable to the Student's t statistic) reports each lab's deviation in units of standard deviations. The Z Score is the calculated number of standard deviations a sample mean is above or below the population mean. The criteria for the Z Scores will be as follows:

[Z] <2 = satisfactory
2<[Z] <3 = questionable
[Z] >3 = unsatisfactory

Z-Scores outside this range should occur only about one time in twenty, if a laboratory has average capability running the method. Laboratories should strive to obtain Z Score values close to zero. The Z-Score is calculated as follows:

$$\text{Z Score} = (\text{lab average} - \text{total average}) / \text{total standard deviation}$$

10.5 *Identification of Outlier Data*—During the analytical review of the data it was observed that when including all data in the calculation of the Overall Average and Std. Deviation, in some cases, the averages and standard deviations are adversely affected by outlier data. Therefore, through two iterations of calculations, labs who had a Z-Score Value of $\pm$ 3 or greater have been asterisked in the table. These data, while still included in the tables, have not been included in the statistical analysis. This step of excluding data is only performed through two iterations. After the second iteration, all remaining data have been included in the resulting statistical analysis.

10.6 *Flags*—This column contains reference to data outside either three standard deviations or the upper limit of the Range Chart. A "1" indicates that the lab's average exceeds 3 standard deviations, a "2" indicates that the lab's range exceeds the upper range limit.

10.7 *High-Low Charts*—These are provided for each sample as a visual comparison of laboratory performance. The "Y" scale represents the test results and "X" scale the laboratory codes. Each laboratory's data is plotted. The length of the whiskers represents the high-low range of the five test results for each lab. Horizontal lines are provided at the Overall Average and Overall Average plus/minus three standard deviations.

10.8 *Range Graph*—This is provided to chart individual Lab Ranges against the Total Range Average. The Upper Control Limit is determined by multiplying 2.114 times the Total Range Average.

11. Keywords

11.1 calibration; proficiency testing; program coordinator; testing laboratory; Z score

APPENDIX

(Nonmandatory Information)

X1. A CHECK LIST FOR INVESTIGATING THE ROOT CAUSE OF UNSATISFACTORY ANALYTICAL PERFORMANCE

INTRODUCTION

To identify why a laboratory's data may have been considered a statistical outlier and/or improve the precision, the following action items are suggested. There may be additional ways to improve the performance.

1) Check the results for typos, calculation errors and transcription errors.
2) Reanalyze the sample: check for repeatability.
3) Check the sample for homogeneity or contamination and that a representative specimen has been analyzed.
4) Review the test method and ensure that the latest version of the ASTM test method is being used. Check the procedure step by step with the analyst.
5) Check the instrument calibration.
6) Check the statistical quality control chart to see if the problem has been developing earlier.
7) Check the quality of the reagents and standards used and whether they are expired or contaminated.
8) Check the equipment for proper operation against vendor's operating manual.
9) Call the vendor for maintenance and/or repairs.
10) After the problem has been resolved, analyze a certified reference material if one is available or the laboratory quality control sample to ascertain that the analytical operation is under control.
11) Provide training to new analysts and if necessary, refresher training to experienced analysts.
12) Document the incident and the learnings for use in future similar problem.