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An American National Standard

Standard Guide for Defining the Test Result of a Test Method[1]

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1. Scope

1.1 This standard provides guidelines for identifying the elements that comprise the test result of a test method and to illustrate how these elements combine into the test result.

1.2 Types of measurement scales used for expressing observations and test results are discussed.

1.3 No system of units is specified in this standard.

1.4 *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

E456 Terminology Relating to Quality and Statistics

2.2 *ISO Standard:*[3]

ISO 3534–2 Statistics—Vocabulary and Symbols, Part 2: Applied Statistics

3. Terminology

3.1 *Definitions*—Unless otherwise noted in this standard, all terms relating to quality and statistics are defined in Terminology E456.

3.1.1 *binary scale, n*—nominal scale with only two possible categories.

3.1.2 *binary test result, n*—a test result for which the final value is one of two possible categories.

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.

3.1.4 *interval scale, n*—continuous scale or discrete scale with equal sized scale values and an arbitrary zero. **ISO 3534–2**

3.1.5 *nominal scale, n*—scale with unordered labeled categories or ordered by convention. **ISO 3534–2**

3.1.6 *observation, n*—the process of obtaining information regarding the presence or absence of an attribute of a test specimen, or of making a reading on a characteristic or dimension of a test specimen.

3.1.6.1 *Discussion*—Observation is also associated with the attribute or measurement information obtained from the process. The term "observed value" is preferred for this second usage.

3.1.7 *observed value, n*—the value obtained by making an observation.

3.1.8 *ordinal scale, n*—scale with ordered labeled categories. **ISO 3534–2**

3.1.9 *ordinal test result, n*—a test result where the final value is reported as one of the scale results on an ordinal scale.

3.1.10 *ratio scale, n*—continuous scale with equal sized scale values and an absolute or natural zero point. **ISO 3534–2**

3.1.10.1 *Discussion*—Ratio scales consist of only non-negative values.

3.1.11 *scale, n*—system of reference values for a characteristic. **ISO 3534–2**

3.1.12 *test determination, n*—the value of a characteristic or dimension of a single test specimen derived from one or more observed values.

3.1.13 *test method, n*—a definitive procedure that produces a test result.

3.1.13.1 *Discussion*—Examples of test methods include, but are not limited to: identification, measurement, and evaluation of one or more qualities, characteristics, or properties. **ASTM Regulations 2.2.6**[2]

3.1.14 *test observation, n*—see *observation*.

3.1.15 *test result, n*—the value of a characteristic obtained by carrying out a specified test method.

3.1.15.1 *Discussion*—The test method specifies that one or a

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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.

[3] Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, Case postale 56, CH-1211, Geneva 20, Switzerland, http://www.iso.ch.

number of individual observations be made, and their average or another appropriate function, (such as the median or the standard deviation), be reported as the test result. It can also require standard corrections to be applied, such as correction of gas volumes to standard temperature and pressure. Thus, a test result can be a result calculated from several observed values. In the simple case, the test result is the observed value itself.

ISO 3534–2

3.1.16 *test specimen, n*—the portion of a test unit needed to obtain a single test determination.

3.1.16.1 *Discussion*—When used for a physical test, this is sometimes called "test piece." For a chemical test, it is sometimes called test portion or test sample. For optical and other tests, it is also sometimes called test sample. In interlaboratory evaluation of test methods and other statistical procedures, it is best to reserve the word sample for the whole amount of material involved and not the individual test specimens, pieces or portions being tested.

3.1.17 *test unit, n*—the total quantity of material (containing one or more test specimens) needed to obtain a test result as specified in the test method. (See *test result*.)

4. Significance and Use

4.1 All test methods have an output in the form of a test result. This guide provides information on the construction of test results from more elemental measurements.

4.2 A well-defined test result is necessary before any precision statements can be made about the test method.

4.2.1 Form and Style for ASTM Standards,[2] Section A21, requires that every test method shall contain a statement regarding its precision, preferably as a result of an interlaboratory test program. Reporting of such studies is described in Practice E177, which illustrates the development of test results from observations and test determinations.

4.2.2 Precision statements for ASTM test methods are applicable to test results. They are not applicable to test determinations or observations, unless specifically and clearly indicated otherwise.

5. Scales

5.1 The test method must clearly identify the scale for measuring the test observations and reporting the test results. Measurement scales are classified into various types. The primary classification is into numerical or categorical scales. Numerical scales, also known as quantitative scales, are established in terms of a defined numerical range with specified scale divisions. Categorical scales, also known as qualitative scales, are defined in terms of words, but the categories may be assigned numbers for purposes of data analysis.

5.2 Measurement scales may be sub-classified into a hierarchal system denoted as nominal, ordinal, interval, and ratio scales as follows:

5.2.1 A *nominal* scale is an unordered categorical scale. Examples include blood types (A, B, O) or categories of defect types.

5.2.1.1 A *binary* scale is the special case of a nominal scale with only two categories. An example is the presence or absence of some condition in a test specimen or in conducting a test method, such as a pipe or glass breaking after an impact, a cigarette igniting a piece of fabric, or a light bulb turning on.

5.2.2 An *ordinal* scale is an ordered categorical scale. An example is a rating scale comprising four categories: poor, fair, good, and excellent.

5.2.2.1 Worded categories may be assigned numbers, such as 1 = poor, 2 = fair, 3 = good, 4 = excellent.

5.2.2.2 The differences in categories, whether in numbers or labels, are not uniform and are often arbitrary or subjective.

5.2.3 An *interval* scale is a numeric scale with an arbitrary zero. Such scales may consist of negative and positive numbers, rounded to a defined number of significant figures. An example is the Celsius scale for temperature where 0 °C is defined as the freezing point of water.

5.2.3.1 Differences are meaningful on an interval scale. A difference of 10 °C is the same change in temperature throughout the scale.

5.2.4 A *ratio* scale is a numeric scale with an absolute zero, and all values are non-negative numbers. Examples are the length of an item or the temperature as measured on the Kelvin scale.

5.2.4.1 Ratios, as well as differences, are meaningful on a ratio scale.

5.3 *Other Types of Scales:*

5.3.1 A number of special types of scales may be constructed or utilized. These may involve non-linear scales such as logarithmic or power scales. Other situations may involve censored numerical responses where values that would be below a lower limit, or above an upper limit, are not reported numerically.

6. Developing the Test Result

6.1 A test method may have three distinct stages: (*1*) the direct measurement or observation of dimensions or properties, or the occurrence of an event; (*2*) the arithmetical combination of observed values to obtain a single determination; and (*3*) the arithmetical combination of a number of determinations to obtain the test result of a test method.

6.2 *Observation:*

6.2.1 An observation or observed value should be interpreted as the most elemental single reading or corrected reading obtained in the process of making a test or measurement.

6.2.2 An observation may be a classification into one of two categories or a numerical value on a continuous scale. An observation may involve a direct reading (for example, a zero-adjusted micrometer reading of the thickness of a test strip at one position along the strip) or it may require the interpolation of the reading from a calibration curve.