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Standard Practice for Sampling in Rubber Testing—Terminology and Basic Concepts[1]

This standard is issued under the fixed designation D 6085; 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 covers a standardized terminology and some basic concepts for testing and sampling across the broad range of chemical and physical testing operations characteristic of the rubber and carbon black manufacturing industries.

1.2 In addition to the basic concepts and terminology, a model for the test measurement process is given in Annex A1. This serves as a mathematical foundation for the terms and other testing concepts. It may also find use for further development of this practice to address more complex sampling operations.

1.3 This general topic requires a comprehensive treatment with a sequential or hierarchical development of terms with substantial background discussion. A number of ancillary terms are also given that make for a more self-contained document. This cannot be accommodated in Terminology D 1566.

1.4 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 1566 Terminology Relating to Rubber[2]

D 4483 Practice for Determining Precision for Test Method Standards in the Rubber and Carbon Black Industries[2]

D 5406 Practice for Rubber—Calculation of Producer's Process Performance Indexes[2]

3. Terminology

3.1 *Definitions:*

3.2 Despite the adoption of standard test methods, test result variation influences the data generated in all testing programs. As outlined in Annex A1, there are two main categories: (*1*) variation inherent in the production process for a material or class of objects, and (*2*) variation due to the measurement operation itself. Each of these two sources may be further divided into two types of variation: (*1*) systematic or bias variation, and (*2*) random error variation. Both types can exist simultaneously for either of the main categories.

3.3 Random variation can be reduced to a low level by appropriate replication and sampling procedures, but bias variation cannot be so reduced. However, bias variation can be reduced or eliminated by comprehensive programs to sort out the causes of such perturbations and eliminate these causes.

3.4 *Elementary Testing Terms:*

3.4.1 *material*, *n*—a specific entity that exists in bulk form (solid, powder, liquid).

3.4.2 *Discussion*—A material may or may not be homogeneous. Typical materials are individual rubbers, compounds, accelerators, carbon blacks, etc.

3.4.3 *object*, *n*—a discrete item or piece with a specified shape and size.

3.4.4 *Discussion*—Usually an object is an entity that is ready for testing. A typical object is an o-ring, dumbbell, pellet, or hose assembly.

3.4.5 *object class (or class of objects)*, *n*—a number of objects, with a recognized property range, generated by a common process, the objects are usually characterized by the value(s) of a unique property.

3.4.6 *Discussion*—In any testing program the phrase" a recognized property range" implies that the tester is aware of the approximate value of this range. At one extreme, this recognized range may denote "essentially identical property values;" at the opposite extreme this recognized range may denote "widely varying property values." The range applies to both materials and object classes, and testing programs will differ in regard to the extent of variation under consideration.

3.4.7 *test (or testing)*, *n*—a technical procedure performed on a material or object class using specified equipment that produces data unique to the material or object class; the data are used to evaluate or model selected properties or characteristics.

3.4.7.1 *Discussion*—Testing can be conducted on a narrow or broad basis, depending on the decisions to be made for any program. Sampling and replication plans (see 3.5) need to be specified for a complete program description.

[1] This practice is under the jurisdiction of Committee D11 on Rubber and is the direct responsibility of Subcommittee D11.16 on Application of Statistical Methods.

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[2] *Annual Book of ASTM Standards*, Vol 09.01.

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3.4.8 Testing may be divided into two major categories:

3.4.8.1 *local testing, n*—testing that is conducted at one location or laboratory for the purpose of comparing a number of materials or object classes for some selected characteristic properties.

(*a*) *Discussion*—Quality control and internal development programs are typical local testing.

3.4.8.2 *global testing, n*—testing that is conducted at two or more locations or laboratories for the purpose of comparing materials or object classes at each location for selected characteristic properties.

(*a*) *Discussion*—Typical global testing applications are producer-user testing and interlaboratory comparisons such as precision evaluation. These may be conducted on a worldwide basis.

3.4.9 *population*, *n*—a generic term used in testing operations that may refer to any one of the following: (*1*) a single object or a very limited mass of material, (*2*) a finite (but large) number of objects or large mass of material, or (*3*) a hypothetical infinite number of objects or mass of material; all three interpretations imply that the objects or material are generated by some identifiable process and have recognized property range.

3.4.9.1 *Discussion*—Testing programs may vary from a very limited focus of attention (Interpretation 1) to an extreme or broad focus of attention (Interpretation 3). The focus of attention is determined by the testing and the sampling program.

3.4.10 *lot*, *n*—a specified mass of material or number of objects, generated by an identifiable process, with a recognized composition or property range.

3.4.10.1 *Discussion*—A lot is frequently generated by a common production process in a restricted time period and usually consists of a finite size or number. A lot may be a fractional part of a population (Interpretation 2 of *population*).

3.5 Sampling and Related Testing Terms:

3.5.1 *sample*, *n*—a small fractional part of a material or a specified number of objects that are selected from a lot for testing, inspection, or specific observations of particular characteristics.

3.5.1.1 *Discussion*—A sample may be obtained from the combination of a series of incremental parts, each part obtained in one step of a particular sampling process (see *sub-sample*).

3.5.2 *sub-sample*, *n*—one of a sequence of intermediate fractional parts or intermediate sets of objects taken from a lot or population that usually will be combined in a prescribed protocol to form a sample.

3.5.3 *random sample*, *n*—one of a sequence of samples (or sub-samples) taken on a random basis from a lot or population.

3.5.4 *systematic sample*, *n*—one of a sequence of samples (or sub-samples), each taken from a particular location or region of a lot or population according to a prescribed plan; the usual goal is to determine if the lot or population is homogeneous.

3.5.4.1 *Discussion*—Non-homogeneity may be of a random nature or it may be systematic (variation), which is frequently referred to as "stratification."

3.5.5 *sampling*, *n*—the act of selecting samples of any type.

3.5.5.1 *Discussion*—The goals of sampling are (*1*) an accurate or representative evaluation of the characteristic properties of the lot or population, and (*2*) an accurate estimate of the variation of properties within the lot or population.

3.5.6 *replicate*, *n*—a generic term used in testing operations that denotes one of a selected number of fractional parts or objects taken from a sample; each fractional part or object is tested.

3.5.7 *replication*, *n*—the act of selecting replicates.

3.5.7.1 *Discussion*—The primary purpose of replication is the reduction of random test measurement variation. See Annex A1 for additional discussion on types of replication.

3.5.8 *test sample*, *n*—that part of a sample of any type taken (usually with a prescribed blending or other protocol) for chemical or other analytical testing.

3.5.8.1 *Discussion*—A test sample may be a replicate or it may be subdivided into *n* replicates; these *n* replicates are frequently called "laboratory samples." Test samples are typically drawn to represent materials such as rubbers, pigments, chemicals, etc.

3.5.9 *test specimen*, *n*—an object (appropriately shaped and prepared) taken from a sample for physical or mechanical testing.

3.5.10 *Discussion*—A test specimen is usually a replicate. Test specimens are typically prepared by a rubber processing (and curing) operation to evaluate characteristic properties of development compounds and the compounds used in manufactured rubber products. They may also be manufactured rubber parts such as o-rings, motor mounts, etc.

3.5.11 *test portion*, *n*—see *test sample*, the preferred term.

3.5.12 *test piece*, *n*—see *test specimen*, the preferred term.

3.6 Testing Variation Terms—Annex A1 defines a number of test data variation terms (see A1.4). Some additional terms, as given below, apply to typical development testing as well as quality control and quality assurance.

3.6.1 *common cause variation*, *n*—that residual variation inherent in any process that (*1*) is operating in a state of statistical control, and (*2*) is operating at some recognized or ascertained level of technological competence (Practice D 5406).

3.6.2 *special cause variation*, *n*—that variation attributable to certain specific or assignable sources that have been (or may be) discovered through an investigation of the process (Practice D 5406).

3.6.2.1 *Discussion*—Both common and special cause variation may contain bias as well as random variation components. A synonym for common cause variation is *non-assignable variation*; a synonym for special cause variation is *assignable variation*.

3.6.3 *total process variation*, *n*—a range, along the measured property scale, defined as six times the standard deviation (determined under specified process conditions); the variation may contain either common or combined common and special cause sources (Practice D 5406).

3.6.3.1 *Discussion*—Although this is defined in terms of quality control operations, it applies equally to general testing. For this general testing, the "process" and the "standard deviation" refer to the total (testing and sampling) operation.

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