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# Standard Practice for Mechanical Sampling of Coal[1]

This standard is issued under the fixed designation D7430; 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.

$\varepsilon^1$ NOTE—7.4 and 8.1.1.5 were editorially corrected in November 2011.

## INTRODUCTION

Analysis data obtained from coal samples are used in establishing price, controlling mine and cleaning plant operations, allocating production costs, and determining plant or component efficiency. The task of obtaining a sample of reasonable weight to represent an entire lot presents a number of problems and emphasizes the necessity for using standard sampling procedures.

Coal is one of the most difficult of materials to sample, varying in composition from noncombustible particles to those which can be burned completely, with all gradations in between. The task is further complicated by the use of the analytical results, the sampling equipment available, the quantity to be represented by the sample, and the degree of precision required.

This practice gives the overall requirements for the collection and within-system preparation of coal samples through the use of mechanical sampling systems utilizing falling stream, cross belt and auger designs. This practice also gives the overall requirements for the bias testing and quality management of mechanical coal sampling systems. The wide varieties of coal-handling facilities preclude the publication of detailed procedures for every sampling situation. The proper collection of the sample involves an understanding and consideration of the physical character of the coal, the number and weight of increments, and the overall precision required.

## 1. Scope

1.1 This practice is divided into 4 parts. These 4 parts represent the previous standards D7256/D7256M, D4916, D4702, and D6518. These 4 standards are the 4 that govern the mechanical sampling of coal and have been combined into one document for the ease of reference of the users of these standards.

### Part A

1.2 *Part A—Mechanical Collection and Within-System Preparation of a Gross Sample of Coal from Moving Streams*—Covers procedures for the mechanical collection of a sample under Classification I-B-1 and I-B-2 (Practice D2234/D2234M) and the within-system preparation (reduction and division) of gross samples utilizing various components of the mechanical sampling system.

1.2.1 Part A describes mechanical sampling procedures for coals *(1)* by size and condition of preparation (for example, mechanically cleaned coal or raw coal), and *(2)* by sampling characteristics.

1.2.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

### Part B

1.3 *Part B—Mechanical Auger Sampling*——Describes procedures for the collection of an increment, partial sample, or gross sample of material using mechanical augers. Reduction and division of the material by mechanical equipment at the auger is also covered. Further manual or mechanical reduction

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or division of the material elsewhere shall be performed in accordance with Practice D2013.

1.3.1 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

### Part C

1.4 *Part C—Quality Management of Mechanical Coal Sampling Systems*—Is applicable to the quality management of cross-belt, falling stream, and auger sampling systems.

1.4.1 Spacing of increments pertains to the kind of interval between increments. Intervals can be defined in quantitative terms, such as units of time or mass, or in terms of position over the lot.

1.4.2 *Spacing of Increments for Cross-Belt and Falling Stream Samplers*—Cross-belt and falling stream type mechanical sampling systems take increments based on time, either at fixed time intervals or at random times during a fixed time strata. Some falling stream samplers can take increments based on equal mass of coal sampled as determined by scales. The sections of this practice that pertain to cross-belt and falling stream samplers describe procedures for only time-based sampling systems. This time-based inspection guideline will satisfy most criteria for mass-based or combination mass-based and time-based sampling systems. If there are items that are not covered, the inspector should refer to the manufacturer's literature.

1.4.3 *Spacing of Increments for Auger Sampling*—The spacing of increments collected by auger sampling systems is defined in terms of position over the lot.

1.4.4 It is essential that the inspector have the documentation listed in Section 2 of this practice when conducting an inspection.

1.4.5 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

### Part D

1.5 *Part D—Bias Testing of a Mechanical Coal Sampling System*—Presents sample collection and statistical evaluation procedures for testing mechanical sampling systems (including auger systems), subsystems, and individual system components for bias. It is the responsibility of the user of this practice to select the appropriate procedure for a specific sampling situation.

1.5.1 Part D does not purport to define an absolute bias. Bias defined by this practice is the difference between the population mean of the mechanical sampler test results and the accepted reference value.

1.5.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.6 *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.* For a specific hazard statement, see section 16.1.

## 2. Referenced Documents

2.1 *ASTM Standards:*[2]

D121 Terminology of Coal and Coke

D2013 Practice for Preparing Coal Samples for Analysis

D2234/D2234M Practice for Collection of a Gross Sample of Coal

D4621 Guide for Quality Management in an Organization That Samples or Tests Coal and Coke[3]

D4702 Practice for Quality Management of Mechanical Coal Sampling Systems[3]

D4749 Test Method for Performing the Sieve Analysis of Coal and Designating Coal Size

D4916 Practice for Mechanical Auger Sampling[3]

D6518 Practice for Bias Testing a Mechanical Coal Sampling System[3]

D7256/D7256M Practice for Mechanical Collection and Within-System Preparation of a Gross Sample of Coal from Moving Streams[3]

E105 Practice for Probability Sampling of Materials

E122 Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process

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

E456 Terminology Relating to Quality and Statistics

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

## 3. Terminology

3.1 *Definitions*—Definitions applicable to this practice are listed in Terminology D121.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *accuracy*, *n*—*(1) generally*, a term used to indicate the reliability of a sample, a measurement, or an observation; *(2) specifically*, a measure of closeness of agreement between an experimental result and the true value. An example is the observed and true sulfur content of a coal consignment. This measurement is affected by chance errors as well as by bias.

3.2.2 *activation interval*, *n*—*for a falling-stream or cross-belt cutter*, the time from the beginning of movement for taking an increment, to the beginning of movement for taking of the next increment.

3.2.3 *auger increment*, *n*—the retained portion of one extraction operation of the auger.

3.2.4 *auger sampler*, *n*—a mechanical device that extracts a columnar sample of coal from a railcar, truck, barge or stockpile and any associated sub-system or within-system components.

3.2.5 *bias*, *n*—the difference between the population mean of the mechanical sampler test results and the accepted reference value.

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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] Withdrawn. The last approved version of this historical standard is referenced on www.astm.org.

3.2.6 *confidence interval*, *n*—a numeric interval with a lower limit and a higher limit within which the true parameter value is estimated to fall. The confidence interval percentage indicates the percentage of time the true value will fall within the interval if the procedure is continuously repeated.

3.2.7 *consignment*, *n*—a discrete amount of coal, such as a shipment, a car load, a unit train, or a day's production. A consignment may include more than one lot of coal and may correspond to a specific period of time, such as a sampling period or a billing period.

3.2.8 *correlation*, *n*—a measure of the linear dependence between paired system and reference measurements. Correlation frequently is expressed by the correlation coefficient, which can take a value from minus one (perfect negative linear relationship) to plus one (perfect positive linear relationship).

3.2.9 *cross-belt sampler*, *n*—a single sampling machine or component of a mechanical sampling system designed to extract an increment directly from a conveyor belt surface by sweeping a sampling device (cutter) through the material on the conveyor.

3.2.10 *delimitation error*, *n*—a material error that occurs when all the elements in a cross section of a coal stream do not have an equal probability of being intercepted (captured) by the sampler cutter during increment collection.

3.2.11 *ellipsoidal region*, *n*—an area that is formed by plane sections of ellipses that are defined by the values selected for the largest tolerable bias of each coal characteristic used in the bias test. The region will be used to determine if the system is biased.

3.2.12 *falling-stream sampler*, *n*—a single sampling machine or component of a mechanical sampling system designed to extract an increment from a falling stream of coal at the discharge end of a conveyor or chute by moving a sampling device (cutter) through the falling stream of material.

3.2.13 *Hotelling's* $T^2$ test, *n*—a statistical test that is used to evaluate multivariate data. It is the multivariate equivalent of the Student's *t*-test.

3.2.14 *largest tolerable bias (LTB)*, *n*—an interval whose upper and lower bounds represent the limits of an acceptable bias.

3.2.15 *mechanical sampling system*, *n*—a single machine or series of interconnected machines whose purpose is to extract mechanically, or process (divide and reduce), or a combination thereof, a sample of coal.

3.2.16 *paired data set*, *n*—system and reference values observed on samples collected and compared from the same batch of material.

3.2.17 *precision*, *n*—a term used to indicate the capability of a person, an instrument, or a method to obtain reproducible results; specifically, a measure of the chance error as expressed by the variance, standard error, or a multiple of the standard error (see Practice E177).

3.2.18 *reference sample*, *n*—a sample used in testing of a mechanical sampling system which is comprised of one or more increments collected from the test batch or lot of coal by the stopped belt method as described in Practice D2234/D2234M.

3.2.19 *reject stream*, *n*—the coal flow within a mechanical sampling system, which occurs at each stage of division, before and after reduction, and is not included in the system sample.

3.2.20 *save stream*, *n*—the coal flow within a mechanical sampling system which occurs at each stage of division, before and after reduction, and after the final stage of division becomes the system sample.

3.2.21 *statistical independence*, *n*—two sample values are statistically independent if the occurrence of either one in no way affects the probability assigned to the occurrence of the other.

3.2.22 *surrogate sample*, *n*—a sample, used in the evaluation of a mechanical sampling system, which is comprised of one or more increments collected from a coal stream within the mechanical sampling system in accordance with Practice D2234/D2234M, Conditions "A" or "B." Such a sample may be considered acceptable for evaluation of a mechanical sampling system's components, excluding the primary cutter, when demonstrated to be equivalent to the reference sample.

3.2.23 *system sample*, *n*—a sample collected from a test batch or lot of coal by the mechanical sampling system being tested for bias.

3.2.24 *unbiased sample (representative sample)*, *n*—a sample free of bias.

3.2.25 *Walsh averages*, *n*—given a series of observations (differences) $x1$, $x2$, ... $xn$, the $n\ (n + 1)/2$ pair-wise averages given by:

$$(xi + xj)/2,\ 1 \le i \le j \le n \tag{1}$$

3.2.25.1 *Discussion*—As an example of Walsh averages, assume one has three observations (differences) designated as $x1$, $x2$, and $x3$. There are then a total of $3(4)/2 = 6$ Walsh averages. They are as follows: $x1$, $x2$, $x3$, $(x1 + x2)/2$, $(x1 + x3)/2$, and $(x2 + x3)/2$.

3.2.26 *Wilcoxon Signed Rank Test*, *n*—a non-parametric statistical procedure for calculating the point estimate and confidence interval for a sample drawn from a population with symmetric distribution.

3.2.27 *within-system preparation*, *n*—the process of gross sample preparation carried out mechanically by sequential crushing (reduction) equipment and/or division equipment. It may be carried out by processing increments individually or by batching increments together and processing them together as a group. In any case, within-system preparation is conducted in a manner to minimize moisture changes and without removing the gross sample or its increments from the sampling system.