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Standard Practice for Collection of a Gross Sample of Coal[1]

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INTRODUCTION

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 mass 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 of coal samples. 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 mass of increments, and the overall precision required.

1. Scope

1.1 This practice covers procedures for the collection of a sample under various conditions of sampling and directs the user to the appropriate ASTM standard for that sampling condition. The sample is to be crushed and further prepared for analysis in accordance with Practice D2013/D2013M. However, the procedures for dividing large samples before any crushing are given in this practice.

1.2 This practice describes general and special purpose sampling procedures for coals *(1)* by size and condition of preparation (for example, mechanically cleaned coal or raw coal) and *(2)* by sampling characteristics.

1.3 *Units*—The values stated in either SI units or non-SI units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

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

1.5 *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]

D121 Terminology of Coal and Coke
D2013/D2013M Practice for Preparing Coal Samples for Analysis
D4749 Test Method for Performing the Sieve Analysis of Coal and Designating Coal Size
D6609 Guide for Part-Stream Sampling of Coal
D6883 Practice for Manual Sampling of Stationary Coal from Railroad Cars, Barges, Trucks, or Stockpiles
D7430 Practice for Mechanical Sampling of Coal
E456 Terminology Relating to Quality and Statistics

3. Terminology

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

[1] This practice is under the jurisdiction of ASTM Committee D05 on Coal and Coke and is the direct responsibility of Subcommittee D05.23 on Sampling.

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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.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *accuracy, n—*

3.2.1.1 *generally*—a term used to indicate the reliability of a sample, a measurement, or an observation.

3.2.1.2 *specifically*—a measure of closeness of agreement between an experimental result and the true value. Example: the observed and true sulfur content of a coal consignment. This measure is affected by chance errors as well as by bias.

3.2.2 *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.

3.2.3 *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.

3.2.4 *gross sample, n*—a sample representing one lot of coal and composed of a number of increments on which neither reduction nor division has been performed.

3.2.5 *increment, n*—a small portion of the lot collected by one operation of a sampling device and normally combined with other increments from the lot to make a gross sample.

3.2.6 *judgment sampling, n*—a procedure whereby enumerators select a few items of the population, based on visual, positional, or other cues that are believed to be related to the variable of interest, so that the selected items appear to match the population.

3.2.6.1 *Discussion*—In the case of sampling coal, this statistical terminology from Terminology E456 is stating that the enumerator (human sampler) selects items from the population (collects sample increments) based on various cues (time/tonnage, at transfer point, etc.) so that the items (sample increments) appear to match the population (representative sample). The key dynamic here is that the sampler is attempting to collect a representative sample using their best judgment as to when and how to collect increments when, *(a)* so many particles in the consignment have a zero chance of being selected; and *(b)* there is no sure way to overcome particle size segregation in the material.

3.2.7 *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 system sample of coal.

3.2.8 *nonprobability sample, n*—a sample of which the sampling units have not been selected in a manner that satisfies the minimum requirements of probability sampling.

3.2.8.1 *Discussion*—No meaningful statistical inference can be made with data obtained by a nonprobability sample. No meaningful statement can be made concerning the precision, standard error, or bias of the sample.

3.2.9 *probability sample, n*—a sample collected using a sampling process such that at each stage of the process, a specified non-zero probability of being selected for the sample can be attached to every sampling unit in the lot to be sampled.

3.2.9.1 *Discussion*—Given adequate information about the sample results obtained using probability sampling, the probability distribution of sampling errors can be estimated.

3.2.10 *representative gross sample, n*—a gross sample collected in such a manner that the particles in the original lot are proportionally represented by mass in the gross sample and the moisture content has been reasonably protected from any changes.

3.2.11 *representative prepared sample, n*—a representative gross sample that has been either dried, reduced, or divided, or a combination thereof, according to the procedures contained in Practice D2013/D2013M.

3.2.11.1 *Discussion*—If the sample has been dried, then the prepared sample is no longer representative for moisture content.

3.2.12 *sample, n*—a quantity of material taken from a larger quantity for the purpose of estimating properties or composition of the larger quantity.

3.2.13 *size consist, n*—the particle size distribution of a coal.

3.2.14 *system sample, n*—a sample collected from a test batch or lot of coal by the final stage of a mechanical sampling system.

3.2.14.1 *Discussion*—A system sample that includes reduction and division within the sampling system is no longer a gross sample.

4. Summary of Practice

4.1 The general-purpose sampling procedures are intended to provide, in 19 of 20 cases, dry ash results that are within an interval of ±1/10 of the average dry ash results that would be obtained in hypothetical repeated sampling.

4.2 Special-purpose sampling procedures apply to the sampling of coal when other precision limits are required, or when other constituents are used to specify precision, or for performance tests.

4.3 For coals of known size and condition of preparation, tables are given for the determination of the number and mass of increments required for a gross sample for both general and special-purpose sampling.

4.4 The procedures appear in the following order:

Test Method	Section
Sampling of Coals Based on Size and Condition of Preparation	8.1
General-Purpose Sampling	8.1.1
Number and Mass of Increments	8.1.1.2
Number of Gross Samples	8.1.1.4
Special-Purpose Sampling	8.1.2
Number and Mass of Increments	8.1.2.2
Number of Gross Samples	8.1.2.3
Division of the Gross Sample Before Crushing	8.2
Sampling of Coal for Total Moisture Determinations	8.3
Types of Moisture Samples	8.3.1
Entire Gross Sample	8.3.1.1
Special Moisture Subsample	8.3.1.2
Other Subsamples for Moisture Testing	8.3.1.3
Special Precautions	8.3.2
Mass of Increments	8.3.3
Number of Increments	8.3.4
Moisture Sampling Based Only on Size	8.3.4.1

5. Significance and Use

5.1 It is intended that this practice be used to provide a sample representative of the coal from which it is collected. Because of the variability of coal and the wide variety of sampling equipment, caution should be used in all stages of sampling, from system specifications and equipment procurement to equipment acceptance testing and actually taking the final sample.

5.2 After further processing (Practice D2013/D2013M), the sample may be analyzed for a number of different parameters. These parameters may affect the lot's value, its ability to meet specifications, its environmental impact, as well as other properties.

6. Increment Collection Classification

6.1 The type of selection, the conditions under which individual increments are collected, and the method of spacing of increments from the coal consignment or lot are classified according to the following descriptions and Table 1. These designations are to be used for sampling specifications and for descriptions of sampling programs and sampling equipment.

6.2 *Types of Increments*—The types of selection of increments are based on whether or not there is human discretion in the selection of the pieces of coal or portions of the coal stream.

6.2.1 *Type I,* in which specific pieces or portions are not subject to selection on a discretionary basis. This includes that in which the increment is collected in precise accord with previously assigned rules on timing or location that are free of any bias. Type I selection increments generally yield more accurate results.

6.2.2 *Type II,* in which some measure of human discretion is exercised in the selection of specific pieces of coal or of specific portions of the stream, pile, or shipment.

6.3 *Conditions of Increment Collection*—The conditions under which individual increments are collected are the conditions of the main body of coal relative to the portion withdrawn. Four conditions are recognized:

6.3.1 *Condition A (Stopped-Belt Cut),* in which a loaded conveyor belt is stopped and a full cross-section cut with parallel sides is removed from the coal stream. The distance between the parallel faces shall not be less than three times the normal top size of the coal.

6.3.2 *Condition B (Full-Stream Cut),* in which a full cross-section cut is removed from a moving stream of coal.

6.3.3 *Condition C (Part-Stream Cut),* in which a portion, not a full cross section, is removed from a moving stream of coal.

6.3.4 *Condition D (Stationary Coal Sampling),* in which a portion of coal is collected from a pile, a rail car, a barge, or a ship hold. Mechanical sampling with an Auger is Condition D sampling.

6.3.5 The first two Conditions A and B, Stopped Belt Cut and Full Stream Cut, respectively, are considered probability samples because every particle in the lot has a non-zero chance of being selected and the sample collection method overcomes any particle size segregation in the material. The latter two Conditions C and D, Part-stream Cut and Stationary Sampling, respectively, are considered nonprobability samples primarily because there are large numbers of particles in the lot that have a zero chance of being selected for the sample and the sampling method cannot assure overcoming any particle size segregation in the consignment. In addition, Conditions C and D are often referred to as judgment samples because the increments are not collected according to probability but primarily based on the human judgment of the sampling personnel.

6.3.6 The highest possible condition according to Table 1, wherever feasible, should be used for sample collection, and probability sampling is strongly preferred over nonprobability or judgment sampling.

6.4 *Spacing of Increments*—The spacing of increments pertains to the kind of intervals between increments. Two spacing methods are recognized: systematic and random. Systematic spacing is usually preferable.

6.4.1 *Systematic Spacing 1,* in which the movements of individual increment collection are spaced evenly in time or in position over the lot.

6.4.2 *Random Spacing 2,* in which the increments are spaced at random in time or in position over the lot.

7. Organization and Planning of Sampling Operations

7.1 This practice provides definitive procedures for the collection of a gross sample. Parties claiming to use this practice must adhere to the procedures as set out in this standard. If the sampling is not done in accordance with the procedures set out in this practice, then that sample may not be suitable for comparison with a sample collected by the procedures described in this practice. Since it may be impracticable or impossible to take another sample of a given lot of coal, it is essential that parties agree on sampling procedures prior to undertaking sampling.

7.2 *Selection of Appropriate Sampling Procedure*—Variations in coal-handling facilities make it impossible to publish rigid rules covering every sampling situation in complete and exact details. Proper sampling involves an understanding and proper consideration of the minimum number and

TABLE 1 Increment Types, Conditions, and Spacing

Condition of Increment Collection from the Main Body of Coal	Types of Increment			
	Type I No Human Discretion Is Used		Type II Human Discretion Is Used	
	Spacing of Increments		Spacing of Increments	
	1. Systematic	2. Random	1. Systematic	2. Random
Condition A, stopped belt cut	I-A-1	I-A-2	II-A-1	II-A-2
Condition B, full-stream cut	I-B-1	I-B-2	II-B-1	II-B-2
Condition C, part-stream cut	I-C-1	I-C-2	II-C-1	II-C-2
Condition D, stationary sampling	I-D-1	I-D-2	II-D-1	II-D-2

mass of increments, the size consist of the coal, the condition of preparation of the coal, the variability of the constituent sought, and the degree of precision required.

7.2.1 *Number and Mass of Increments*—The number and mass of increments required for a given degree of precision depends upon the variability of the coal. This variability increases with an increase in free impurity. A coal high in inherent impurity and with comparatively little free impurity may exhibit much less variability than a coal with a low inherent impurity and a relatively high proportion of free impurity. For most practical purposes, an increase in the ash content of a given coal usually indicates an increase in variability. It is imperative that not less than the minimum specified number of increments of not less than the minimum specified mass be collected from the lot. For Condition D, the increments shall be of equal mass.

7.2.2 *Condition of Preparation*—If there is any doubt as to the condition of preparation of the coal (for example, mechanically cleaned coal or raw coal), the number of increments for raw coal shall apply. For the purpose of application of the minimum number of increments in Table 1, mechanically cleaned coal is defined as coal, which has been mechanically cleaned by a specific gravity process in all sieve sizes above 150 µm [No. 100 USA Standard]. Similarly, although a coal has been mechanically cleaned, it may still show significant variation. For example, the coal may be a blend of two different portions of one seam or a blend of two different seams. In such cases where significant variation is possible, the number of increments should be as specified for raw (uncleaned) coal.

7.2.3 *Increment Collection Method to Be Used*—To obtain proportional representation of all particle sizes, it is most desirable that the sample increments be withdrawn from the full cross section of the stream. The best possible increment is a full cross-section cut removed from a stopped belt, Classification I-A-1 in Table 1. The best possible increment from a flowing stream of coal is one obtained by moving a cutter device entirely across the stream at a uniform speed, the same for each increment, into one side of the stream and out of the other, without allowing the receptacle to overflow (Classification I-B-1 in Table 1).

7.2.4 For each of the four Conditions of sampling, use the standard below.

7.2.4.1 *Condition A*—Stopped Belt Cut is covered by Practice D7430, Part D—see Practice D7430, Annex A.1. This standard is used primarily in the collection of the reference samples in a bias test but is also feasible if multiple conveyor belt stops and starts are allowed.

7.2.4.2 *Condition B*—Full-stream Cut is covered by Practice D7430, Part A—Standard Practice for the Mechanical Sampling of Coal. This standard is to be used whenever full-stream cut mechanical sampling is available utilizing either Cross-stream sampler or Cross-belt sampler designed primary cutters.

7.2.4.3 *Condition C*—Part-stream Cut is covered by Guide D6609. This standard is to be used for both the manual and mechanical sampling of coal while it is being moved by conveyor belt and a full-stream cut cannot be collected.

7.2.4.4 *Condition D*—Stationary Sampling is covered by Practice D6883. This standard is to be used for manual and mechanical sampling of coal whenever it is not being moved by conveyor belt.

7.2.4.5 The Condition D sampling using a mechanical auger is covered by Practice D7430, Part B.

7.2.4.6 To test a sampling system for bias, use Practice D7430, Part D—Bias Testing a Mechanical Coal Sampling System.

7.2.5 If a sample is needed for size consist analysis according to Test Method D4749, collect a separate sample of the mass indicated in Test Method D4749 to avoid using the sample required for the determination of moisture content.

7.2.6 It is good practice to separate large consignments into multiple sub-lots for analysis. Unless specifically required, one sizing sample can be used to represent an entire consignment, as long as the sample increments are collected at regular intervals throughout the entire consignment.

7.2.7 For the sampling of coal under Classification I-B-I, see Practice D7430. Classification methods given in Table 1 are listed in order of decreasing reliability. The highest possible classification method, wherever feasible, should be used. Details of sampling procedures should be agreed upon in advance by all parties concerned. Whenever circumstances dictate utilization of increment collection classifications “Condition C” or “Condition D” or “Type II,” details of sampling procedure shall be agreed upon in advance by all parties concerned.

7.3 *Distribution of Increments*—It is essential that the increments be distributed throughout the lot to be sampled. This distribution is related to the entire volume of the lot, not merely its surface or any linear direction through it or over it. If circumstances prevent the sampler from applying this principle, the lot is sampled only in part, and the gross sample is representative only of this part. The spacing of the increments shall be varied if the possibility exists that increment collection may get “in phase” with the sequence of coal variability. Example: routine sampling of commercial coal from a continuous stream (conveyor belt) in which increment collection is automatic and its sequence coincides with the “highs” or “lows” in the content of fines.

7.4 *Dimensions of Sampling Device*—The opening of the sampling device shall be no less than 3 times the nominal top size of the coal and no less than 30 mm [1.25 in.]. The sampling device shall be of sufficient capacity to completely retain or entirely pass the increment without spillage at the maximum rate of coal flow.

7.5 *Characteristics and Movement of Sampling Device*—In sampling from moving streams of coal, the sampling device shall be designed to collect each increment with no selective rejection of material by size and with no contamination by nonsample material.

7.6 *Relative Location of Sampling and Weighing*—It is preferable that coal be weighed and sampled at the same time. If there is a lapse in time between these two events, consideration should be given by both the purchaser and the seller to changes in moisture during this interval and the consequent