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Standard Practice for Mechanical Auger Sampling[1]

This standard is issued under the fixed designation D 4916; 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 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 or division of the material elsewhere shall be performed in accordance with Method D 2013.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 *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.*

[1] This practice is under the jurisdiction of ASTM Committee ~~D-5~~ D05 on Coal and Coke and is the direct responsibility of Subcommittee D05.23 on ~~Coal Sampling.~~ Sampling .

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2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 431 Method 2013 Practice for Designating the Size of Preparing Coal from Its Sieve Analysis Samples for Analysis
D 2013 Method 2234/D 2234M Practice for Collection of Preparing Coal Samples for Analysis a Gross Sample of Coal
D 2234 Practice 4749 Method for Collection Performing the Sieve Analysis of a Gross Sample of Coal and Designating Coal Size
E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

3. Terminology

3.1 *Definitions:*

3.1.1 *accuracy*:

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

3.1.1.2 *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.

3.1.2 *auger increment*—the retained portion of one extraction operation of the auger.

3.1.3 *bias (systematic error)*—an error that is consistently negative or consistently positive. The mean of errors resulting from a series of observations that does not tend towards zero.

3.1.4 *chance error*—error that has equal probability of being positive or negative. The mean of the chance errors resulting from a series of observations tends toward zero as the number of observations approaches infinity.

3.1.5 *consignment*—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.

3.1.6 *error*—difference of an observation or a group of observations from the best obtainable estimate of the true value.

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

3.1.8 *increment*—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.

3.1.9 *lot*—a quantity of coal to be represented by the gross sample.

3.1.10

3.1.4 *precision*—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 E 177).

3.1.11 *representative sample*—a sample collected in such a manner that every particle in the lot to be sampled is equally represented in the gross or divided sample.

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

3.1.13 *sample division*—a process whereby a sample is reduced in weight without change in particle size.

3.1.14 *significant loss*—any loss that introduces a bias in final results that is of appreciable economic importance to the concerned parties.

3.1.15 *size consist*—the particle size distribution of a coal.

3.1.16 *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.

3.1.16.1 *systematic spacing 1*—in which the movements of individual increment collection are spaced evenly in time or in position over the lot.

3.1.16.2 *random spacing 2*—in which the increments are spaced at random in time or in position over the lot.

3.1.17 *subsample*—a sample taken from another sample.

3.1.18 *top size*—the opening of the smallest screen in the series upon which is retained less than 5 % of the sample (see Method D 431).

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3.1.5 *unbiased sample (representative sample)*— a sample free of bias.

4. Summary of Practice

4.1 A sample of coal is extracted from a stationary load contained within a railcar(s), truck(s), or barge(s) by inserting an auger into the vehicle in a vertical manner to extract a columnar sample of coal from the vehicle. The coal collected by the auger is then

[2] Discontinued; see

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *1988 Annual Annual Book of ASTM Standards*, Vol 05.05. *volume information, refer to the standard's Document Summary page on the ASTM website.*

placed into sealed containers for storage or is processed by additional sampling equipment, for example, a secondary sampler or crusher. The processed auger increments produced by these on-line components should be placed into sealed containers for future laboratory analysis.

5. Significance and Use

5.1 Auger sampling systems can be used to extract samples from trucks, railcars, barges, or static compacted stockpiles where the use of a full-stream mechanical sampling system may be impractical. The samples obtained from these systems can be used to establish the materials' commercial value or constituents for quality control purposes at the shipping or receiving location of the interested parties in the transaction. The utilization of an auger system and procedures for collecting coal samples for subsequent analysis should be agreed upon by all parties concerned. Compacted stockpiles should be no higher than the length of the auger sampler. Otherwise, the deeper areas of the stockpile cannot be sampled.

6. Organization and Planning of Sampling Operations

6.1 *General Considerations*—Mechanical auger sampling is designated as Condition D, Stationary Coal Sampling. When using augers to sample, the material taken may only be representative to the depth sampled. In addition, the parameters such as top size, degree of preparation, degree of material segregation, and pattern of auger placement should also be considered.

6.2 *Consideration of Top Size*—Designs of mechanical sampling augers vary from high-powered augers with cutter bits drilling through the coal to be sampled, to low-powered augers designed to sample loosely compacted coal. The clearance in the auger assembly and flights should be sufficient to allow passage of the largest top size in the lot of coal to be sampled. If the top size of coal makes the auger size impractical, the auger should be designed to cut through or break up the lumps of coal.

6.3 *Consideration for Number of Auger Increments* —The number of increments required should be based on the lot size and degree of material preparation. For purposes of this practice, the degree of preparation is divided into two categories, that is, raw and mechanically cleaned. The lot size may be determined by factors such as prior contractual agreements, operational restrictions, coal storage capabilities, and coal transportation methods such as rail car, truck, or barge. Determine the number of increments required to represent the lot by the following formula:

$$N_2 = N_1\sqrt{(a/908 \text{ Mg or } 1000 \text{ tons})}$$

where:
N_1 = 15 for clean coal and 35 for raw coal,
N_2 = number of increments required, and
a = lot size, Mg (tons).

6.3.1 Determine recommendations for the number of auger increments per vehicle by the following formula:

$$N_3 = N_2 \times b/a$$

where:
N_2 = number of increments required,
N_3 = number of increments per vehicle,
a = lot size, Mg (tons), and
b = amount of material per vehicle, Mg (tons).

If N_3 is greater than one, round it off to the nearest whole number. If N_3 is less than one, it is recommended that one increment be taken from each vehicle.

6.3.2 However, if operational considerations make the application of these procedures impractical, the following suggestions may be considered:

6.3.2.1 *Example 1*—When more than one increment per vehicle is recommended but deemed impractical, then take as many increments as possible, but never less than one increment per vehicle. It should be realized that any reduction in the number of increments could reduce the precision of the final sample. In any case, obtain the same number of increments from each vehicle within the lot.

6.3.2.2 *Example 2*—When N_3 is less than one and one increment per vehicle has not been selected as practical, then use the following procedure: take the reciprocal of N_3(that is, calculate $1/N_3$) and round off this value to the nearest whole number. This is now the number of vehicles per increment. Next, space the increments over the number of vehicles either systematically or randomly while noting these precautions; although systematic spacing (for example, one increment every second vehicle for 100 vehicles) may be preferred in other sampling practices, practical consideration must be given to the phenomena of cyclical variability which is common in this type of sampling operation. If systematic spacing is not chosen, random spacing (for example, distributing the 50 increments randomly over the next 100 vehicles) must ensure the elimination of human discretion. This may be done by preplanning and the use of various random-number generator schemes.

6.3.2.3 *Example 3*—When sampling a leveled, compacted stockpile, consideration must be given to the number of increments necessary to represent the lot. It is recommended that a stockpile be divided into lots of not over 45 Mg (50 000 tons). The number of increments required per lot size would be in accordance with 6.3 of this practice.

6.4 *Considerations for Auger Placement Patterns and Increment Collections*—The ease of extracting the auger increments from various portions within the vehicle will be predicted upon the auger design, vehicle type, and support facility limitations. However, it is recommended that a random sampling location pattern be developed to maximize the number of locations from where the auger can extract an increment. Human discretion should be minimized with respect to auger placement to the extent possible. When the lot to be sampled is comprised of vehicles having different cargo capacities, the user should be aware that the auger increment extracted may result in a disproportionate representation of sample from certain vehicles within the lot.

6.4.1 *Sampling Leveled Compacted Stockpiles*—The shape of the area to be represented by each gross sample determines the grid pattern for increment collection. Increments are to be collected at the intersection of the grid pattern. Each grid section should represent equal area as near as possible.

6.4.1.1 The grid pattern must include the slope of the pile. Also, the slope of the pile may not be as compacted as the top. Take care to ensure adequate sampling of the slope.

6.4.2 *Stockpiles of Less than 3-m (10-Ft) Height*—The preferred device to be utilized on stockpiles of less than 3-m (10-ft) height is a mobile, mechanical, truck-mounted auger. This device will penetrate to the pile base.

6.4.2.1 The use of an auger to sample a stockpile must be considered a Class D Method. It should be used only if a higher method is not possible. Because of auger design, all of the fine material from the bottom of a pile may not be collected. All parties should agree on the use of the auger method before it is used.

6.4.3 *Stockpiles of Greater Than 3-m (10-Ft) Height* —The preferred device to be utilized on a stockpile of over 3-m (10-ft) height is a hollow-stem auger and split-spoon sampler that will allow the deepest penetration into the pile and identify the base. If the hollow-stem auger and split-spoon sampler is used, the option of producing a three-dimensional ~~griding~~ grid exists. In a three-dimensional grid pattern, each grid must represent equal area. Increments are to be collected at the intersection of the grid pattern.

6.4.4 *Stockpile Sampling Records*—Sampling technicians should keep a written log with notations of all the conditions encountered during increment collection. Items to be noted may include size of the stockpile, size-segregation patterns, general configuration of the stockpile, weather conditions including the ambient temperature, degree of compaction of the stockpile, perimeter conditions of the pile, degree of contamination, and visual appearance of the material.

6.5 *Preservation of Moisture*—The increments obtained during the sampling period should be protected from changes in composition due to exposure to rain, snow, wind, sun, contact with absorbent materials, and extremes of temperature. The circulation of air through equipment must be reduced to a minimum to prevent loss of both fines and moisture. Samples in which moisture content is important shall be protected from excessive airflow and stored in moisture-tight containers. Containers with airtight lids and heavy gage vapor-impervious bags tightly sealed are satisfactory for this purpose.

6.6 *Contamination*—The sampling arrangement shall be planned so that contamination of the increments with foreign material or unrelated coal is avoided.

6.7 *Mechanical System Features*—It is essential that the entire auger system, that is, cutters, chutes, conveyors, crushers, be self-cleaning and be designed in a manner that will minimize the need for maintenance.

6.8 *Personnel*—Because of the many variations in the conditions under which coal must be sampled, it is essential that the samples be collected under the direct supervision of a person qualified by training and experience for this responsibility. Where human discretion is employed in collecting the increments, it is essential that the samples be collected by a trained and experienced person or under the direct supervision of such a person.

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

6.10 *Reduction and Mechanical Division of the Auger Increments*:

6.10.1 *Division of Auger Increments Before Crushing*:

6.10.1.1 *Number of Increments*—If each retained increment is reduced in quantity by secondary sampling, take at least six secondary increments from each retained auger increment. This method of collection of secondary increments should be proven to be free from bias.

6.10.1.2 *Opening of Sampling Device*—The opening of the sampling device shall be at least 2½ to 3 times the top size of coal but in no case less than 31.8 mm (1¼ in.).

6.10.1.3 *Speed of Sampling Device*—To prevent segregation and rejection caused by disturbance of the coal stream, practical evidence indicates that the velocity with which the cutting instrument travels through the stream should not exceed 457 mm/s (18 in./s). However, if greater cutter speeds are used, it is desirable to verify that they are free of bias under the normal range of expected conditions.

6.10.2 *Division of Auger Increment After Crushing*:

6.10.2.1 *Number of Increments*—Because of the various methods of loading and transporting material, stratification and segregation of material within the auger barrel may exist. This problem may be intensified by the nonuniformity in size of the crushed sample. It is recommended that a minimum of three secondary crushed increments per auger increment be collected and spaced evenly throughout the extracted auger increment.

6.10.2.2 In most auger installations involving on-line crushing, the sample is normally reduced in size to 10 mm (⅜ in.) or less. Regardless of the final sample size, the cutter opening shall be no less than 31.8 mm (1¼ in.) in width. A cutter opening greater than 31.8 mm may be required in some cases to prevent bridging of the cutter opening, and consideration should be given to the material size, moisture content, coal-flow characteristics, and velocity at the cutter. In those cases where the auger increment is crushed to a larger top size than 10 mm, the cutter opening shall not be less than 2½ to 3 times the material top size.

6.10.2.3 *Speed of Sampling Device (After Crushing)*—To prevent segregation and rejection caused by disturbance of the coal stream, practical evidence indicates that the velocity with which the cutting instrument travels through the stream should not exceed 457 mm/s (18 in./s). However, if greater cutter speeds are used, it is desirable to verify that they are free of bias under the normal range of expected conditions. Depending upon the sampler design, speeds slower than 457 mm/s may be desirable, especially when the cutter opening is set at the 38.1-mm dimension. Consideration should be given to the material feed angles to the sampler, particle size, moisture, flow characteristics, and flow rate to ensure nonpreferential extraction.

6.10.2.4 *Size of Increment*—In consideration of the individual increment weights, each increment should be of a weight sufficient to overcome internal factors such as airflow within the chutework, friction on the chute surfaces, and other factors affecting potential moisture losses. It is recommended that each secondary increment weigh a minimum of 50 g (1.8 oz).

7. Precision and Bias

7.1 At this time, sufficient performance data with respect to precision and bias is not available to establish statements in regard to the performance range for all of the auger designs and operating conditions. Some auger sampler installations have been shown to produce precision commensurate with Test Methods D 2234, Condition B.

8. Keywords

8.1 auger sampling; barge sampling; railroad car sampling; split-spoon sampling; stock pile sampling; truck sampling