DRAFT INTERNATIONAL STANDARD

ISO/DIS 13909-8

ISO/TC **27**/SC **4** Secretariat: **SABS**

Voting begins on:
2014-07-08

Voting terminates on:
2014-10-08

Hard coal and coke — Mechanical sampling —

Part 8:
Methods of testing for bias

Houille et coke — Échantillonnage mécanique —

Partie 8: Méthodes de détection du biais

ICS: 75.160.10;73.040

Reference number
ISO/DIS 13909-8:2014(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 13909-8 was prepared by Technical Committee ISO/TC 27, *Solid mineral fuels*, Subcommittee SC 4, *Sampling*.

This second edition cancels and replaces the first edition (ISO 13909-8:2001), which has been technically revised.

ISO 13909 consists of the following parts, under the general title *Hard coal and coke — Mechanical sampling*:

— *Part 1: General introduction*

— *Part 2: Coal — Sampling from moving streams*

— *Part 3: Coal — Sampling from stationary lots*

— *Part 4: Coal — Preparation of test samples*

— *Part 5: Coke — Sampling from moving streams*

— *Part 6: Coke — Preparation of test samples*

— *Part 7: Methods for determining the precision of sampling, sample preparation and testing*

— *Part 8: Methods of testing for bias*

Introduction

It is not possible to lay down a standard method for field work by which a sampling procedure can be tested for bias because details of the procedure will inevitably be affected by local conditions. However, certain principles can be specified which should be adhered to whenever possible and these are discussed in this part of ISO 13909.

Testing for bias can be a tedious and expensive process. All bias tests therefore include a thorough pre-test inspection, with appropriate action taken regarding any system deficiencies likely to cause bias.

Hard coal and coke — Mechanical sampling — Part 8: Methods of testing for bias

1 Scope

This part of ISO 13909 sets out principles and procedures for testing the bias of test samples of hard coals or cokes, taken in accordance with other parts of ISO 13909.

NOTE In the text the term 'fuel' is used where both coal and coke would be applicable in the context and either 'coal' or 'coke' where only one is applicable.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 13909-1, *Hard coal and coke — Mechanical sampling — Part 1: General introduction*

ISO 13909-2, *Hard coal and coke — Mechanical sampling — Part 2: Coal — Sampling from moving streams*

ISO 13909-4, *Hard coal and coke — Mechanical sampling — Part 4: Coal — Preparation of test samples*

ISO 13909-5, *Hard coal and coke — Mechanical sampling — Part 5: Coke — Sampling from moving streams*

ISO 13909-6, *Hard coal and coke — Mechanical sampling — Part 6: Coke — Preparation of test samples*

ISO 13909-7, *Hard coal and coke — Mechanical sampling — Part 7: Methods for determining the precision of sampling, sample preparation and testing*

ISO 21398:2007, Hard coal and coke — *Guide to the inspection of mechanical sampling systems.*

3 Terms and definitions

For the purposes of this part of ISO 13909, the terms and definitions given in ISO 13909-1 apply.

4 Principles

4.1 General

The testing of a sampling system for bias is based on taking a series of pairs of samples of essentially the same fuel; one member of each pair being sampled by the system or component under test, the other member being obtained by a reference method. For each pair, the difference between the analytical results is determined. The series of differences between the analytical results thus obtained are subjected to statistical analysis.

The sensitivity of the statistical test is dependent on the number of pairs compared, the variability of the differences between members of the pairs and the number of parameters used for the test.

The statistical analysis to which results will be subjected assumes three conditions:

— a multivariate normal distribution of the variables;

— independence of the errors of measurement for the individual parameters;

— homogeneity of the data.

5 Pre-test inspection

The primary sources of information regarding compliance with the sampling standard are the equipment specifications and drawings.

A thorough examination of the sampling system and a review of its component specification shall be made (see ISO 21398).

The party performing the test shall, however, verify performance by field measurements and observations. The operation of the sampling system shall be observed both dynamically with fuel flowing and statically with no fuel flowing. Some components will need to be actuated in static mode.

Pre-test inspections of all operations and equipment, both static and under load, should be carried out by persons experienced in the sampling of segregated, heterogeneous, lumpy bulk materials. It is recommended that operation under normal conditions be observed for an entire lot.

Do not execute a test for bias until all conditions known to cause bias are corrected, unless it is necessary to establish the performance of a system or component as it stands. In the latter case, the pre-test inspection provides essential documentation of what the conditions were at the time of the test.

6 Reference methods

To test overall system bias, the use of a reference method which is known to be intrinsically unbiased is required. The preferred method is the stopped-belt method, i.e. the collection of increments from a complete cross-section of the fuel on the conveyor belt by stopping the belt at intervals. When properly collected from the primary fuel stream, the stopped-belt increment can be considered as a reference increment.

NOTE 1 If it is not possible to collect stopped-belt increments, other reference methods may be used but, in these cases, an apparent absence of a lack of bias relative to the reference method may not be conclusive and the use of such methods may compromise the validity and authority of the findings.

NOTE 2 With collection of stopped-belt increments, some disruption of normal operations can occur and therefore the plan of execution may need to be coordinated with the normal operations and organized to minimize such disruption. It should be recognized that the conveyor system involved may be used for only a few hours per day for normal operations and cannot be operated solely for bias tests, unless the fuel can be diverted to another discharge point. This can extend the time necessary for completion of the field work and require special arrangements for supplying fuel to the system for testing.

Stopped-belt increments shall be taken with a sampling frame (see Figure 1), or equivalent, from a complete cross-section of the solid mineral fuel on the belt at a fixed position, for a length along the belt which is at least three times the nominal top size of the fuel.

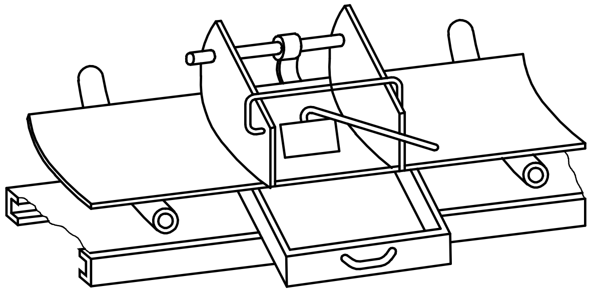

Figure 1 — Sampling frame

The sampling frame (or equivalent) shall be placed on the stationary belt at the predetermined position so that the separator plates at each end are in contact with the belt across its full width. All particles lying inside the sampling frame end plates shall be swept into the sample container.

Particles obstructing the insertion of the end plate on the left-hand side shall be pushed into the increment while those obstructing the insertion of the end plate on the right-hand side shall be pushed out of the increment or vice-versa. Whichever practice is used initially, this practice shall be implemented throughout the test.

Take care to minimize the risk of bias being introduced in the course of preparation of the increments and samples and check all sample division equipment and procedures for bias with respect to relevant test parameters.

It is recommended that all increments/samples be weighed immediately after collection. Close attention shall be given to minimizing unintended mass losses.

All observed mass losses shall be reported.

7 Test design

7.1 Choice of test parameters

The standard test for general purposes shall include moisture and ash (ash on a dry basis). Use of these two parameters will generally suffice. Other variables can be included if desired. However, given a fixed number of sample pairs, the test often becomes less sensitive to detection of a bias as additional variables are included.

Bias in ash content on a dry basis is most commonly caused by errors in size distribution. Bias in moisture content may be caused by a wide variety of factors, including but not limited to errors in size distribution, moisture losses associated with crushers, excessive ventilation within the sampling system, less than the closest possible coupling between system components, excessive retention time in the system, or any combination of these.

Direct tests on particle size distribution are often necessary for coke. It is recommended that tests for size distribution be conducted as a separate test and that size distribution parameters not be included in the standard test for analytical parameters.

7.2 Number of paired samples

The minimum number of paired samples for the test shall be 30. However, if use of a smaller number of paired samples results in a detection of bias, no additional samples need be collected. After completing the statistical calculations the resulting confidence region can be evaluated. If no bias is detected yet the confidence region covers levels of bias that are of commercial concern, more paired samples can be collected of fuel originating from this same source in order to reduce the size of the confidence region.

7.3 Selection of sample pairs

7.3.1 Composition of sample pairs

The members of each pair of samples can each be comprised of portions of one or more increments. Individual increments can be paired or samples of compounded increments can be paired. The test shall be structured so that the expected mean of the differences of the result would be zero if no systematic error is present in the system under test.

7.3.2 Paired-increment samples

Paired-increment experimental design is the comparing of individual primary increments after being processed by the system, with the reference samples collected from the stopped belt.

NOTE 1 A final system sample consisting only of fuel collected from a single primary increment may be of insufficient mass to provide an analytical result following the requirements specified in ISO 13909-4 and ISO 13909-6 for preparation and analysis by the methods used routinely during regular operations.

NOTE 2 In causing the mechanical system to separately collect and process individual primary increments for a test for bias, the system sample may lose more moisture than while the system is operating as designed.

7.3.3 Paired-batch samples

It is often not practical to obtain single increment samples from the system. Increments taken by the system can be compounded as samples and paired with samples compounded from increments taken over the same period using the reference method. It is not necessary that the two sample members, reference and system, have the same number of increments or be of similar mass. Single stopped-belt reference increments are often used as the reference sample and paired with compounded system sample increments. In collecting paired-batch samples, the timing at which stopped-belt increments are collected from each moving batch shall be determined using a stratified random sampling scheme.

7.4 Choice of coal for test

If more than one coal is to be sampled by the system, the coal chosen for the bias test shall be one that is expected to show up any bias in the sampling system. For example, bias for ash on primary samplers and sample dividers is commonly caused by the exclusion of larger sized particles. If a coal is chosen where the ash content of such particles is similar to that of the coal as a whole, yet the particles are too large for collection, then no bias will be detected even though those particles are being excluded. If subsequently the sampler is used to sample a coal where the large particles have an ash content which differs from the mean, the sampling system could be biased by not accurately representing those particles.

It is recommended that the complete bias test be carried out on a coal from a single source.

7.5 Coke

The same requirements as those specified in 7.4 for coal with respect to its ash content shall apply when choosing a coke for the bias test with respect to its moisture content.

8 Conduct of the test

8.1 General

The whole system shall be tested by comparing stopped-belt reference samples taken from the primary flow with the product at the final stage of the preparation system. A bias test for the whole system is carried out by comparing the reference samples taken from the main flow with the samples collected at the final stage of the on-line system. The paired batch experimental design (see 7.3.3) is the preferred practice, because it minimizes the disruption of normal operations.

Bias may be hardware induced, system logic induced, or a combination of both. It follows that routine operating conditions are best simulated by operating sampling systems under the control of system logic at routine operating condition settings. In using the paired increment methodology, the sampling system downstream of the primary sampler must not be stopped by system interlocks. This can be facilitated by use of a bias-test mode of system operation. This is not an issue in paired batch tests.

Conveyor belt systems for handling fuel are often not designed for repeated starting and stopping under load. The paired increment experimental design does not necessarily preclude collection of stopped-belt increments, provided arrangements are made to stop the feed to the belt from which the increment is to be collected before the belt is stopped, so that the belt will be only partially loaded on restart. Increments can then be collected off the belt from the points in the stream where conditions that prevailed before the feed was stopped still exist.