
**Hard coal and coke — Guidance to the
inspection of mechanical sampling
systems**

*Houille et coke — Lignes directrices pour l'inspection des systèmes
d'échantillonnage mécanique*

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Contents

Page

Foreword.....	iv
Introduction	v
1 Scope	1
2 Normatives references	1
3 Terms and definitions.....	1
4 Safety	2
5 General considerations	2
5.1 Precision.....	2
5.2 Bias.....	2
5.3 Operation of sampling system	2
6 Establishment of inspection system	3
6.1 General.....	3
6.2 Audit — External	3
6.3 Audit — Internal	4
6.4 Operational inspections.....	4
7 Procedures	4
7.1 Audit — External	4
7.2 Audit — Internal	5
7.3 Operational inspections	6
8 Quality control.....	6
8.1 General.....	6
8.2 Sampling ratio	6
8.3 Coefficient of variation	7
8.4 Extraction ratio.....	7
8.5 Sampling records.....	7
8.6 Operators' inspection report	8
Annex A (informative) Monitoring coal sampling ratios using control charts.....	11
Annex B (informative) Examples of sampling checklists.....	15
Annex C (informative) Example of sampling plant operators inspection report	18
Annex D (informative) Example of sampling plant operations inspection summary.....	23
Bibliography	25

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 21398 was prepared by Technical Committee ISO/TC 27, *Solid mineral fuels*, Subcommittee SC 4, *Sampling*.

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Introduction

The objective of this International Standard is to provide users of new and existing mechanical sampling systems for minerals with guidance on their operation and inspection.

An 'informative' annex is for information and guidance only.

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Hard coal and coke — Guidance to the inspection of mechanical sampling systems

1 Scope

This International Standard sets out recommended practices for the inspection of mechanical sampling systems. It serves as a reference for conformance with applicable ISO/TC 27 International Standards.

This International Standard covers general considerations including precision, mineral variability and bias, establishment of inspection systems and inspection procedure.

2 Normatives 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 13909-2:2001, *Hard coal and coke — Mechanical sampling — Part 2: Coal — Sampling from moving streams*

ISO 13909-3, *Hard coal and coke — Mechanical sampling — Part 3: Coal — Sampling from stationary lots*

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

ISO 13909-5:2001, *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 13909-8:2001, *Hard coal and coke — Mechanical sampling — Part 8: Methods of testing for bias*

3 Terms and definitions

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

3.1 audit

(external) critical review of a mechanical sampling system, which measures its compliance with stipulated operating specifications, undertaken by a suitably qualified independent person who is not directly involved in the management of that particular system

**3.2
audit**

(internal) critical review of a mechanical sampling system, which measures its compliance with stipulated operating specifications, undertaken by a suitably qualified person who is not a day-to-day operator of that particular system

**3.3
operational inspection**

observations and inspections of operation conditions undertaken by the operator during sampling of a consignment

NOTE The operator is the person responsible for monitoring the sampling system on a shift-to-shift basis.

4 Safety

This International Standard does not purport to address safety issues that can be associated with its use. It is the responsibility of the user of this International Standard to establish appropriate safety and health practices in line with site safety regulations and relevant Occupational Health and Safety Acts. It is highly recommended that the auditor or inspector start by conducting a careful review of all safety rules and procedures regarding the sampling system to be inspected.

5 General considerations

5.1 Precision

Precision checks are recommended for each coal or coke type used in the system. If there is a significant change in a coal or coke type or a new coal or coke type introduced, then a precision check should be carried out. The test should outline the precision of sampling, preparation and analysis of each type of material (or coal and coke) sampled with the system. These tests shall be in accordance with ISO 13909-7.

5.2 Bias

It is recommended that, after commissioning and auditing of a new system or any major engineering modifications of an existing system, a bias test be carried out to confirm the system. If it is intended that the system be verified in accordance with ISO 13909 (all parts) procedures, reference is made to ISO 13909-2:2001, Clause 10, and ISO 13909-5:2001, Clause 10, where bias tests are mandatory. When choosing a coal or coke type for bias testing, refer to ISO 13909-8:2001, 9.1 and 9.2. It is recommended that further bias sample pairs be taken on a regular basis to confirm that the initial bias result is still relevant. If a significant change is made to the sampling system, or a new mineral having more difficult sampling characteristics is introduced, a new bias test should be considered.

5.3 Operation of sampling system

The mechanical plant system should be started some time in advance of the start of conveying the mineral so that any foreign substances (including water) are purged. Where hydraulic drives are used, sufficient time should be allowed for the hydraulic oil and the associated system to attain temperature equilibrium. It is recommended, particularly in multi-coal or coke sampling systems, that one primary cut be allowed to pass through the mechanical system as a conditioner before actual sampling commences.

It is recommended that the operator review any sampling records for the plant maintained by the previous operator. These records should include quantities of coal or coke handled and sampled, and notations as to system malfunctions, stoppages, blockages or other deficiencies. The operator should use a suitable checklist, such as the example given in Annex A. It is recommended that the operator complete all items on a suitable checklist designed for the particular system. For large, multi-user systems, an operators' inspection report, such as the example in given Annex B, should be developed.

Sufficient suitably designed inspection points should be available to observe that the falling-stream and cross-belt cutters cut the full stream of coal or coke and that cutter apertures can be inspected for blockages and blinding.

6 Establishment of inspection system

6.1 General

6.1.1 To ensure reliable operation, it is recommended that a sampling checklist (see Annex B) and operators' sampling record (see Annex C) be developed with input from the following sources:

- a) original design criteria;
- b) sampling equipment operating and maintenance manuals;
- c) management responsible for the system;
- d) personnel operating or maintaining the system;
- e) for a new system, the designers and commissioning personnel;
- f) relevant International Standards where applicable;

6.1.2 The general method for establishing these procedures is as follows.

- a) Reference should be made to (ISO 13909-2 and ISO 13909-5) to ascertain the correct sampling scheme.
- b) Reference should be made to the equipment supplier's operating and maintenance manual to ascertain correct procedures for operation and intervals for routine maintenance. The manuals can provide useful information on the basis of the system design. Such information as conveyor rates, conveyor speeds, material parameters (particularly sizing and variability) are significant data and should always be kept in mind when changes are contemplated.
- c) Existing sampling and maintenance records for an extended period should be examined. This information provides guidance for operators to ensure that the required level of inspection and maintenance is carried out to ensure reliable operation and possibly to alert operators to any inappropriate maintenance or modifications that can have been made to the equipment.
- d) Personal experience of maintenance, operational and sampling personnel should be sought with respect to the sampling system. This information, together with that obtained from items b) and c), enable appropriate operators' manual, operators' sampling record and system checklist to be prepared.

6.2 Audit — External

A scheme for regular audits of the sampling system should be established. Reference should be made to the original operating parameters and equipment supplier's design data in order to establish conformance with the currently applicable International Standards.

NOTE Annex B provides a typical reference list.

It is recommended that correct operation of all new systems be confirmed by an audit following the commissioning stage before being accepted as operational. Also, the design and operation of the system should be confirmed by an audit prior to any bias test.

6.3 Audit — Internal

A scheme for routine inspections of the sampling system by operators should be established. The frequency and detail of inspections is determined by such factors as, but not limited to, reliability of the system, handling characteristics of the sampled material and frequency of use of the system and purpose of sampling (e.g. process control compared to large multi-user port facilities).

6.4 Operational inspections

Operational procedures and inspections should be established and carried out immediately before, during and immediately after operation of the sampling system for a given lot or sub-lot. These procedures and inspections are less extensive than those undertaken as audits or mechanical inspections as given in 6.2 and 6.3. They should be designed to be simple inspections of the integrity of the sampling process. For large, multi-user facilities, it is recommended that a system of operational reports, as per the example in Annex B, be developed.

7 Procedures

7.1 Audit — External

When assessing the conformance of a mechanical sampling system, an auditor should refer to Annexes A and B, the relevant parts of ISO 13909-2 and ISO 13909-5, and the design flow chart of the particular system being evaluated. It is recommended that a person who is not directly involved in the operation and management of that particular sampling system carry out an audit at least once per year.

It is essential that reference be made to the original operational parameters upon which the sampling system is designed. Operational conditions such as conveyor capacity, belt speed or material top size can have been altered without due regard to the impact on the operation and conformity of the sampling system.

The following are common examples of such alterations and their potential consequences.

- An increase in the capacity of a conveyor can result in excessive primary increment mass that can no longer be entirely contained by the primary sample cutter.
- A change in conveyor speed can affect the trajectory of material at a transfer point, which can result in a part of the material stream being missed by the sample cutter.
- A change in nominal top size of the coal or coke can result in the original cutter aperture no longer being large enough (i.e. three times nominal top size of the mineral) to conform to the relevant parts of ISO 13909.

Items that should be covered as a minimum are as follows:

- a) safety requirements of site;
- b) original and current operating parameters;
- c) selection of appropriate sampling procedure;
- d) general condition of the equipment, including build-up of material or blockages in chutes, cutters and sample loss or sample contamination. Attention should be paid to wear items or corrosion that can lead to moisture loss from air flow through the sampling system;
- e) confirmation and comparison of design and actual increment masses for all cutters at several flow rates on the product belt, up to the maximum;

- f) condition of cutters, cutter apertures and cutter lips. Check for foreign material such as wood, rags, stones and material that can be blinding the cutter apertures;
- g) conformity to ISO 13909. In particular, the following information should be referenced:
 - 1) minimizing bias;
 - 2) correct design and operation of sample cutters;
 - 3) number of primary increments per lot or sub-lot required;
 - 4) methods of taking primary, secondary or tertiary increments and the division of increments and/or gross samples;
- h) crusher inspection (inspect hammers or rolls and screens for wear and blinding);
- i) determination of the top size of feed and crusher product;
- j) staff training and procedures manual assessment;
- k) check of previous mechanical inspections and operational inspections.

7.2 Audit — Internal

It is recommended that an experienced inspector should start at the primary cutter and follow through the system to the final on-line sample collection point. The mechanical inspection should be made both with and without coal or coke running through the system. Mechanical inspections should be carried out at more frequent intervals than audits. For systems in daily use, it is recommended that the management of the sampling system and not the direct operators of the system carry out mechanical inspections at least once per month.

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The following items should be inspected:

- a) falling-stream and/or cross-belt cutter apertures, to determine that they comply with ISO 13909 requirements and with the design flow chart of the system;
- b) speed in both directions of all cutters. For time-based sampling check that the speed is constant; for mass-based sampling check that the speed is proportional to the flow rate to ensure that the mass of increment is constant;
- c) movement of all cutters to verify uniform speed while in the material stream;
- d) that all cutters take a complete cross-section of material flow;
- e) for all cutters, that the proper number of increments is taken to satisfy the requirements of ISO 13909-2 and ISO 13909-5. It should also be verified that the time or mass interval between primary cuts is correct to assure that the minimum number of increments is collected for the lot of material being sampled during the inspection, based on maximum attainable feed rates;
- f) that all cutters are parked out of the material stream in the at-rest position and that no coal or coke is entering the cutter opening. There should be no holes in the baffle plates, dust doors or seals that can cause leaking of material into the primary sample hopper. In the case of slotted-belt cutters, checks should be undertaken to confirm the aperture size, cutter lips and belt speed;
- g) masses of the sample increments for falling-stream and/or cross-belt cutters to confirm that they conform to ISO 13909-2 and ISO 13909-5;
- h) that the cycle time for all cutters, including dividers, is not evenly divisible into the cycle time of the previous division stage;

- i) that belt feeders (sample conveyors) and vibrating feeders are in good condition. This is especially important for sample integrity. The correct tracking of belts, condition of belts, skirt rubbers and belt scrapers can have a significant impact on sample integrity. Check that the belt scrapers and skirts are adjusted properly to avoid spillages. Check the flow rate settings of vibrating belt feeders;
- j) the general condition of the crusher and the size of the crushed product. Variations in product size over time can indicate that maintenance is required to screens, hammers in hammer-mill crushers and rolls and gaps in roll crushers. Ensure the crusher body and chutes are not spilling material from the system;
- k) final sample collector to determine general condition. Checks should be made to ensure that sample integrity is not being compromised through contamination, sample loss or total moisture loss;
- l) records of previous operations and inspections.

7.3 Operational inspections

Operational inspections should be carried out immediately prior to, during and immediately after each sampling operation. This falls due at changes of shift or material type, or for each lot. The emphasis of operational inspections should be on ensuring that the sampling system is operated at correct settings and that reliable operation is achieved during the sampling period. It is recommended that the direct operators of the system carry out operational inspections. The following points should be checked and reported:

- a) that operational settings are correct, taking into account lot size, sub-lot size, time- or mass-based sampling, number of primary, secondary and tertiary increments, division ratios and sample collection interval;
- b) that all equipment and sample chutes are clear of coal and coke build-up or blockages. Evidence of chute damage due to damage to external walls or scraping should be recorded;
- c) that all equipment and sample chutes are clear of foreign material such as wood, paper, rags, stones or metal;
- d) that all drives have been checked for correct operation, with attention paid to smooth operation of sample cutter drives. Any unusual noises or vibrations should be reported;
- e) that all drives, including hydraulic systems, have been started well before sampling is required. Hydraulic systems require a period of time to attain temperature equilibrium;
- f) that the sampling system has been “conditioned” by passing one or more primary increments through the sampling system before commencing or recommencing sampling. Any sample collected during conditioning should be discarded;
- g) that control charts have been maintained in accordance with Clause 8. This provides evidence of restricted flow through the system, if this occurs. An example of this can be found in Annex C;

8 Quality control

8.1 General

In addition to the operators’ sampling record, it is recommended that control charts also are maintained. Two types of control charts are recommended, viz. for sampling ratio and extraction ratio.

8.2 Sampling ratio

The sampling ratio control chart is a plot of sampling ratio as a function of units sampled, where the sampling ratio, F_{SR} , is defined by Equation (1):

$$F_{SR} = \frac{m_1}{m_2} \times 1000 \tag{1}$$