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Solid mineral fuels — Guidance on the sampling of coal seams

Combustibles minéraux solides — Principes directeurs pour l'échantillonnage des veines de charbon

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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.

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.

International Standard ISO 14180 was prepared by Technical Committee ISO/TC 27, *Solid mineral fuels*, Subcommittee SC 4, *Sampling*.

Annexes A and B of this International Standard are for information only.

Introduction

A coal seam may consist of a single stratum of one lithotype of relatively uniform maceral constitution, or it may consist of a number of layers of different coal lithotypes varying in thickness and lateral extent. The seam may also contain discrete layers of inorganic sediments or carbonaceous shales of varying thickness. Veins of concordant or discordant secondary mineral matter or intrusive igneous rock may also be present. The lithotype layers may vary considerably in hardness, texture and structure according to the nature of the coal and inorganic sediments. The inorganic layers may also thicken laterally, splitting the seam into two or more separate entities. Thus, it is not always possible to obtain samples of a full seam or seam section at one sampling point. Where significant variation in seam thickness, lithotype profile and structure occurs and a representative sample is required, several samples may have to be taken.

Methods of sampling for the assessment of the physical, chemical, petrographic or utilization properties are described for the following:

a) sampling from small and large diameter drill cores;

b) sampling from exposed seam faces;

c) sampling from trial open-cut excavations;

d) sampling from underground workings.

In a seam of variable quality, it will be necessary to take a number of samples to improve the representativity of sampling.

In operating mines, the manager should be consulted and approval should be obtained before sampling sites are selected and sampling proceeds. In all sampling situations, experienced and qualified personnel will be required for supervision and to ensure that accurate records are made of location, thickness and lithotype descriptions and that all safety precautions have been addressed.

Solid mineral fuels — Guidance on the sampling of coal seams

SAFETY PRECAUTIONS — It is strongly recommended that a risk analysis of the sampling exercise be undertaken by an experienced safety officer before work begins.

1 Scope

This International Standard provides guidance on methods for taking samples from coal seams in the ground, whether from exploration tenements, or from operating underground or open-cut mines. The following methods are described:

a) bore core sampling;

b) drill cuttings sampling;

c) open-cut slot sampling;

d) adit, drift or shaft sampling;

e) pillar sampling;

f) channel sampling;

g) strip sampling.

This International Standard does not apply to sampling from moving streams in production or any other source of coal that is not *in situ*.

Recommendations are made for selection and preparation of the sampling site, and methods are described for taking both small and bulk samples, and for preparing the samples for transport.

NOTE Annex A gives an example of a sample record form that may be used to record sampling and other relevant data, and ISO 9411-1 [1] describes how to determine the mass of a representative sample at various nominal top sizes.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 1213-2:1992, *Solid mineral fuels — Vocabulary — Part 2: Terms relating to sampling, testing and analysis*.

3 Definitions

For the purposes of this International Standard, the definitions given in ISO 1213-2 and the following apply.

3.1
bulk sample
sample of large mass, taken in a particular operation for a specific reason, such as for pilot washing, coal preparation or burning tests

NOTE It is not possible to define the minimum size of a bulk sample.

3.2
channel sample
sample of the coal and associated inorganic material taken by removing a channel of even cross-section from the seam

NOTE Where the full section of the seam is not accessible or not required, this term may refer to a sample taken either from a specifically defined portion of the seam, or from the floor to roof as mined or exposed.

3.3
coal seam
stratum or sequence of strata composed of coal as a significant component and significantly different in lithology to the strata above and below it

NOTE It is laterally persistent over a significant area and it will be of sufficient thickness and persistence to warrant mapping or description as an individual unit.

3.4
core sample
cylindrical sample of the whole or part of a coal seam obtained by drilling using a coring barrel

NOTE The diameter of the core may vary from 50 mm to 2 000 mm, depending on the reason for which the sample is required. However, 50 mm to 200 mm is the most common core diameter range.

3.5
cuttings sample
sample of coal chips produced from the rotary drilling of a coal seam using a non-coring bit such as a blade bit or roller bit

3.6
pillar sample
section of a seam taken in the form of a block, or series of blocks, of coal with associated inorganic rock which, when arranged in correct vertical sequence, represent a true section of the seam

NOTE Where the full section of the seam is not accessible or not required, this term may refer to a sample taken either from a specifically defined portion of the seam, or from the floor to roof as mined or exposed.

3.7
ply sample
sample taken from an individual ply or leaf or from a series of plies or leaves of a coal seam

3.8
strip sample
sample similar to a channel sample but smaller in cross-section

NOTE A single strip sample may often be regarded as being too small to guarantee that all horizons of the seam are adequately represented. However, a number of such samples may be taken to achieve better representativity in a variable seam.

4 Selection of sampling site

If a sample is to be taken to provide a representative sample of the seam, the site should be chosen, as far as possible, to avoid cracks and breaks, random lenses of rock or mineral matter, or other abnormalities or irregularities in the face to be sampled. However, on occasion, the purpose may be to sample a particular mode of development of the seam section, in which case the sample should be taken at the best available site exhibiting this feature. The location of the sampling point should be recorded accurately (see clause 6).

5 Sampling procedures

5.1 General

Before sampling an exposed face, the section to be sampled should, as far as practicable, be uniformly dressed and squared up, and any loose, overhanging or protruding pieces of coal or rock should be removed. Where a face is weathered, the immediate surface material should be removed to a depth sufficient to eliminate weathering effects. In the case of underground face sampling, contamination by stone dust is to be avoided, as this will influence the analysis.

Care should also be taken to prevent contamination by out-of-seam materials, or other sources such as drilling fluid.

In all cases, but particularly for lower rank coals, it is imperative that the sample be promptly packed in its container to minimize loss of moisture and be transported to the laboratory as soon as practicable.

If the laboratory cannot begin analysis immediately, arrangements should be made to keep the sample in cold storage to prevent oxidation of the coal. Any coal not being analysed should be returned to cold storage until it is required.

5.2 Core sampling

5.2.1 Purpose of core sampling

Core sampling is usually employed for sampling coal seams that are not exposed in outcrop or by mining. Sometimes, however, this method is used even though exposed faces are available. This is because it is often faster, less labour-intensive and more representative than pillar or strip sampling, especially if a suitable drilling rig is readily available. For example, many open-cut mines take cores of the seam to be uncovered in the next mining strip to obtain coal quality data for mine planning purposes. Coring of the uncovered coal seam by a drilling rig sitting directly on top of the coal is also common practice where specific coal quality parameters need to be known for blending purposes or for specific cargoes where the customer may be particularly sensitive to certain coal properties or inorganic impurities.

Cores can be obtained routinely in diameters ranging from 50 mm to 200 mm depending on the amount of material required for testing. It is generally advisable that, for routine sampling operations, 100 mm cores be taken as this size provides a good compromise between representativity and cost. However, it is now possible to take very large cores where a bulk sample is required for marketing, coal processing or coal utilization studies. These cores are obtainable with a foundation drilling rig (commonly known as a bucket rig) but are generally limited to reasonably shallow depths. In this way, a 100 t sample can be obtained at reasonable cost. The coal is usually loaded directly into a truck and covered for transport to the laboratory or pilot beneficiation plant. When taking this type of sample, it is advisable to drill several small-diameter pilot drill holes at the sampling site, to locate the top of the seam accurately so that coring can begin at a predetermined distance above the seam.

5.2.2 Method of sampling cores

Once the sampling intervals have been defined, the coal from each ply is placed in a suitable container such as a thick plastics bag, 20 litre plastics drum, 200 litre lined drum, PVC split tube or gas desorption cylinder.

NOTE Guidance on core sampling and sampling intervals is contained in AS 2519 [2].

Care should be taken to collect all of the sample, including fines in the bottom of the core split tubes, to maintain representativity. This can be achieved by using a shaped scoop and a paintbrush.

5.2.3 Core sample identification and labelling

Each sample should be given a unique number within a sequential numbering system, preferably commencing with the first sample of the uppermost seam in the hole. For example, 8765/01 would be the first (shallowest) sample from hole number 8765. The sample number should be entered on the sample sheet over the appropriate sample depth interval and written in indelible ink or paint on the outside of the container in which the sample is placed. Individual samples may occupy more than one container, but each container should be clearly marked with the sample number and the number of the container relating to that sample (e.g. 8765/01, 1 of 2). As well as marking the sample number on the outside of the container, a small plastics bag containing a sample tag on which is written the sample number should be placed inside the container, in case the number on the outside is accidently damaged or erased during transport or handling. Aluminium sample tags are recommended for this purpose. If plastics bags are used as the principal sample container, the sample number should similarly be written on both the outside of the bag and on a sample tag placed inside a small plastics bag inside the main container.

Once the samples have been labelled, they should be securely sealed using thick elastic bands or packaging tape for plastics bags, clip-on lids secured with packaging tape for plastics buckets and screw-tightened lids for 200 litre drums. For extra security, plastics bags should be placed in 200 litre drums with the sample numbers, name of tenement, name of company sending the samples and name of laboratory to which they are being despatched. Prior to despatch to the laboratory, the analyst should be informed in writing of the number of samples to be sent and the analyses required. A copy of the sample record sheets should be provided to the laboratory with the analytical instructions.

5.3 Cuttings sampling

5.3.1 Purpose of cuttings sampling

Cuttings sampling is used where core sampling is not possible or not justified in terms of cost for the purpose at hand. It should be realized that cuttings samples are not as representative as core samples and require a great deal of experience on the part of the driller and sampler to obtain representative samples. An instance in which cuttings samples might be adequate would be in the early stages of tenement evaluation where a broad understanding of coal quality is required as a precursor to more detailed core sampling.

5.3.2 Method of cuttings sampling

Cuttings are obtained when drilling with a non-coring drill bit. The size of the cuttings can be very variable but generally ranges from a few millimetres to a few centimetres. As the drill bit advances through the seam, the circulating medium (air, water or drilling mud) transports the cuttings from the bit to the surface and they are collected in a purpose-made container or cyclone or on a shovel held near the hole. Generally, the driller alerts the sampler when a coal seam is intersected, and stops drilling while still circulating the drilling fluid to clear the hole of out-of-seam contamination. When satisfied that the hole is clear, the driller then drills a previously agreed distance, usually one metre, while the sample is collected, and then cleans out the hole again. This procedure is continued through the seam until the seam floor is encountered. The sampler meanwhile washes and selects a representative quantity of cuttings from each sample, places them in bags and labels them while the hole is deepened to the next seam, if more than one seam is being sampled. A variation on conventional cuttings retrieval is the technique of reverse-circulation drilling. In this drilling method, the normal circulation of the drilling medium (down the centre of the drilling rods and back up the annulus between the rods and wall of the hole) is reversed and the drilling fluid is pumped down the annulus, entrains the cuttings, and returns up the centre of the rods, from which the cuttings are recovered and sampled. This method is suitable for sampling unconsolidated sediments and is ideally suited to sampling coal tailings dams.

As in the case of core sampling, foundation drilling rigs can be used to collect very large cuttings samples, generally on a whole-seam basis, where a large quantity of coal is required for utilization testing or any other purpose. Again, the sample is placed directly in a truck, or on a prepared surface for loading later onto a truck with a front-end loader or similar machine. Sizing of coal obtained in this way can be finer than the anticipated run-of-mine coal sizing, but techniques such as reaming may be used to increase the average size if this is mportant.

Another type of cuttings sampling is known as "keyhole sampling". This method involves the fracturing of the coal by blasting in the hole, or reaming followed by the recovery of the broken coal by circulating the drilling medium using hydraulic mobilization and lifting. This method is best suited to sampling deep coal seams that are targeted for underground mining, as an alternative to taking a number of conventional large-diameter cores.

5.3.3 Cuttings samples identification and labelling

Identification and labelling for cuttings samples is similar to the method described for core samples in 5.2.3, except that cuttings samples are generally smaller than core samples, often no more than 500 g, due to the restricted nature of analysis that can be sensibly carried out on them. There is usually no need to place an identification label inside the principal sample container, but a number of cuttings samples can be placed in a larger plastics bag or a plastics bucket for ease of transport.

5.4 Open-cut slot sampling

5.4.1 Purpose of open-cut slot sampling

Slot sampling is a form of bulk sampling used to acquire a large quantity of coal that would be representative of run-of-mine coal from undeveloped deposits amenable to open-cut mining, or undeveloped areas or seams of an existing open-cut mine. Often the purpose is to confirm coal quality, sizing, washability and utilization behaviour, on the pilot or commercial scale, or in a commercial trial. Results from these tests are more reliable than those obtained from core or channel samples and contribute substantially to a development decision.

It is imperative to realize that this type of sampling is subject to relevant legislated acts and regulations and normally can be carried out only with all appropriate authorizations in place and under the direction of suitably qualified mining personnel as prescribed in the relevant legislation.

It is necessary to obtain all of the approvals required before this type of sampling is commenced. This will include environmental approvals.

5.4.2 Method of open-cut slot sampling

Slot sampling requires a full mine design produced by qualified and experienced civil or mining engineers and geologists. Detailed slot design is outside the scope of this International Standard and only general concepts will be discussed.

Factors to be considered in the overall design of the slot include shape, seam dip and depth, ramp grade and width, side-wall and end-wall angles, water management, and topsoil and spoil pile management.

The size of the slot and therefore the complexity of design will depend on the depth to fresh coal, the thickness of the coal seam to be sampled and the size of the sample required. Thus, the first decision to be made is the quantity of coal required for the purposes for which the sample is being taken. This is nfluenced by mining and preparation factors such as mining loss, dilution from mining, expected yield of clean coal after washing and whether subsequent samples are required. The quantity of finished coal product is the basis upon which the whole mine plan is based. The depth to coal and the strength of the overburden are particularly important factors in design because they dictate the type of slot that can be used and hence the cost involved.

Where the coal is relatively shallow and the overburden can be removed by scrapers, the preferred slot design is a double-ramp design as shown in figure 1. In this design, the scrapers remove the overburden down to the top of the coal seam and uncover sufficient coal to produce the amount of finished product that was determined before excavation commenced. This type of slot has the advantage of being easily enlarged later, if more material is required. One common strategy is to uncover twice the width of coal required and mine only half the width using an excavator sitting on the half that is not to be mined, as shown in figure 1. This allows recovery of a similar quantity later for further testing.