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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

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This document 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 14180:1998), which has been technically revised

Introduction

Coal is one of the most challenging materials to sample due to its characteristic heterogeneity. A coal seam can consist of a single stratum of one lithotype of relatively uniform maceral constitution, or more commonly, consist of a number of layers of different coal lithotypes varying in thickness and lateral extent. The seam can also contain discrete layers of inorganic sediments or carbonaceous shales of varying thickness. Veins of concordant or discordant secondary mineral rock could also be present. The lithotype layers can vary considerably in hardness, texture and structure according to the nature of the coal and inorganic sediments. The inorganic layers can also thicken laterally, splitting the seam into two or more separate units which could require multiple samples.

It is strongly recommended that a collaborative team including geologists, mining engineers, safety, land and laboratory professionals review each proposed sampling program to help ensure optimal effectiveness and efficiency are obtained.

The purpose of sampling coal for any resource evaluation is to predict the expected quality of the produced coal from a given locale. Therefore, the fundamental goal of each sampling effort is the collection of representative samples of the seam(s) at each sampling location. A properly executed sampling program needs to accurately define both the lateral variation in coal quality and the average quality for a specified area.

After inspection of any seam, the sampler designes a sampling program with sufficient representative samples to define the range of expected coal quality. In variable seams it is necessary to take a number of samples to improve the representativity of sampling.

In operating mines, the manager needs to be consulted and approval needs to be obtained before sampling sites are selected and sampling proceeds. Where there is no operating mine the area or tenement owner and or operator is consulted.

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.

Methods of sampling for 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.

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

a) sampling of small or large diameter holes;

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 document 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 channel sample record form that can be used to record sampling and other relevant data, and ISO 13909 or ISO 18283 describes how to determine the mass of a representative sample at various nominal top sizes.

2 Normative reference

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 1213-2, *Solid mineral fuels — Vocabulary — Part 2: Terms relating to sampling, testing and analysis*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

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 combustion tests

Note 1 to entry: 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 vertical channel of even cross-section from the seam

Note 1 to entry: Where the full section of the seam is not accessible or not required, this term can 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 1 to entry: 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 1 to entry: The diameter of the core can 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 1 to entry: Where the full section of the seam is not accessible or not required, this term can 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
layer of coal seam normally differing in properties from adjacent layers. Any distinctive layer maybe regarded as a ply

3.8
ply sample
sample taken from an individual ply or leaf or from a series of plies or leaves of a coal seam

3.9
strip sample
sample similar to a channel sample but smaller in cross-section

Note 1 to entry: A single strip sample can often be regarded as being too small to guarantee that all horizons of the seam are adequately represented. However, a number of such samples can be taken to achieve better representativity in a variable seam.

4 Selection of sampling site

4.1 Initial considerations

Sampling sites where possible are chosen at random when no other information regarding the tenement or exploration site is available. The site for sampling apart from drill holes 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).

Core sampling is usually employed for sampling coal seams that are not exposed in outcrop or by mining. It is especially useful in areas which are not readily accessible as drill rigs are small enough to be located by helicopter. Sometimes, however, this method is used even though exposed faces are available. This is because it is often faster, less labour-intensive, safer 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 detailed 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.

NOTE There are risks in comparing data from different core sizes of the same coal. The determined yield values and analysis for washing coals can vary significantly. When this occurs it is recommended that the results be confirmed by very large cores as described above or by practices outlined in 5.4.

4.2 Sampling procedures

No two projects are exactly the same and may have different requirements regarding sampling, such as when and what should be sampled, how the sampling should be done, and the details of how the samples should be numbered or identified, wrapped, recorded, stored and treated.

There are a number of rules related to sampling that should be noted:

a) **Prepare well.** Even if there is little expectation of finding anything of commercial significance, the sampler should always be prepared and in a position to take samples if the opportunity presents. Always have a selection of sample bags, bottles or other containers on hand, in case they are needed.

b) **Ask questions**. Before embarking on a new project, the sampler should discuss the sampling requirements with the Exploration Geologist and or Manager, so it is clear exactly what is required.

c) If in doubt, **take samples rather than not**. Samples that are excess or surplus to requirement can always be disposed of later, but if samples are not taken when the opportunity is available, then the chance to do so may be lost completely. Take more samples than you may think are needed, and divide if uncertain about coal ply boundaries. These can always be recombined in the laboratory following geophysical reconciliation.

d) **Do not put off until tomorrow what you can do today**. For example, if it is late in the day but the project requires that 1m increment soil samples should be collected from the first 10m of the cuttings of an exploration chip borehole, do not leave the cuttings overnight with the intention of collecting the samples the next morning. Do not take the risk that samples could be lost, contaminated or have their integrity compromised.

e) 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.

f) 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.

g) The coal sample after logging and identification should be kept in a sealed bag or container.

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

i) It is critical that sample information is recorded carefully, thoroughly and accurately. There is no value in having a sample that cannot be identified or being able to determine where it came from, or why it was sampled.

j) It is essential that all samples are analysed using rigid quality assurance and quality control procedures. Examples such as duplicate samples, round robins between laboratories, standard samples, laboratory certification to ISO 17025 are recommended in this document.

4.3 Core sampling

4.3.1 Purpose of coal sampling

Core drilling is used to obtain representative samples for geotechnical, coal quality and gas content and other testing to provide as much information from a borehole as possible. A well drilled and recovered core enables precise detail to be recorded on the thickness and brightness of coal bands and the presence of any inter-bedded rock types such as mudstone, siltstone, or tuffaceous material within a coal seam. It also enables the weathered state of the coal to be identified. The combination of detailed lithology logs with coal quality determinations and other test results, supports the determination of working sections and mining methods, coal handing procedures and products.

4.3.2 Core drilling and sampling procedures

The drilling and sampling of core is an expensive and time consuming process. The information available from logging and testing of core contributes significantly to critical decisions about the quantity and quality of the resource and the potential mining conditions. Cores should be highly valued and treated with appropriate care. Tasks when coring include:

a) communicate with the driller about the length of the core run, the depth of the borehole, and the condition of the core;

b) carefully transfer core from driller's splits to PVC splits for logging;

c) clean drilling mud and cuttings from core surface with as little water and disturbance as possible;

d) photograph and log all cores as soon as possible after extraction to minimize disturbance to core;

e) sample coal and partings separately before transferring any material to core boxes, unless significantly different to expected interval or core required for other purpose. In some countries the term used when handling partings and high ash zones is "When in doubt break it out" meaning these zones can be separately sub-sampled, analysed and combined mathematically later. Alternatively the core may be boxed first, logged, and sampled later with the aid of the geophysical logs;

f) any coal core retained should be stored in core sock (plastic tubing) or similar protective covering to minimize moisture loss and further disturbance;

g) minimize evaporation of moisture from coal samples by not leaving exposed for an extended period, sealing samples into plastic bags, and keeping sample bags out of direct sunlight.

4.3.3 Core recovery

There are a number of aspects for good core recovery that should be considered as follows:

a) The mechanical state of the rock, the driller and the drilling methods utilized, and the condition and operation of the coring equipment. It is possible to obtain 100 % core recovery if these factors are all favourable but this is not usual in many situations.

b) **The difference between what is cored and what is recovered needs to be reconciled**. The first step in the core logging process is to measure the length of core recovered.

c) **The rig geologist should accurately determine the borehole depth** before the core is pumped out of the barrel, and be responsible for the measurement of the drilled core run intervals. The rig geologist should ask the driller for the length of the drilled run before the core run is extracted from the core barrel. Once the core is pumped out of the barrel, **the length drilled can then be compared with the recovered length**; Significant differences between the drilled length and the recovered length may be due to measurement or calculation error of the amount drilled, or due to core loss. Therefore all measurements should be rechecked and frequent checks of the driller's depth should be made.

d) Once the core is on the logging table, the rig geologist should make the best attempt possible to close up any gaps, crushed zones and irregularities (e.g. rotate the defect/break for a best fit), or zones of apparent core expansion due to swelling clays or bulking due to discing or mechanical disturbance. The rig geologist should also try to identify the top of the run. **The core should not be manipulated to fit the drilling interval**.

e) The core should then be measured by both the driller and the rig geologist to obtain the measured **recovered length** of core which should then be recorded on the ***Drilling Sheet*** with the driller to depth and the geologist to depth. The difference between the length drilled and the **recovered length** is the 'core loss' or 'core gain'.

f) The apparent expansion of core can of course occur in combination with real core loss. It then becomes difficult to know how much real core loss to assign to versus reducing core length for the cumulative effects of core expansion. Also, although core lost from one core run may be recovered later, each subsequent core run can also be subject to discrete core loss and this should be allocated accordingly.

g) **The core run information is best recorded as a comment** on the ***Lithology Sheet*** **or separate recovery sheet** and should contain the run number, the start of run depth (SOR), end of run depth (EOR), drilled core length and recovered core length. For example: "Run 1: 18.00m to 22.50m, drilled 4.50m, rec 4.32m". A record could also be calculated and recorded of the loss or gain for each core run and the cumulative loss or gain (from values collected on the ***Drilling Sheet***).

h) Where it is difficult to identify where the loss or gain has occurred, a continuous record of the core depths or thicknesses could be made. Any indications of where core loss has occurred should be recorded and depths adjusted later.

i) Some countries for their geotechnical use also calculate rock quality determinations (RQD) at the same time as core recovery.

j) Some countries also carry out **full scale geophysical logging** of cores to provide an accurate seam thickness to confirm core recovery and provide information regarding variation in ash in the seam. The data obtained can also assist in the final sampling of the core.

4.3.4 Core handling and identification

Before samples are sent to the laboratory, the following procedures should be followed to ensure the highest possible standard and reliability of sample collection and analysis:

a) Ensure all samples are taken as soon as possible to minimize moisture loss, otherwise store coal in core sock or with plastic cover.

b) Minimize inclusion of excess free moisture minimize damage to core when separating samples.

c) Recover all possible core with minimal contamination.

d) Use a brush to ensure all possible fines are retained.

e) It is recommended that each sample should also be given a unique number within a sequential numbering system, preferably commencing with the first sample of the uppermost seam in the hole. Record project name, borehole name, and sample number with a water proof pen on the outside of each bag – sample depths may also be included.

f) Record bag number (as bag x of xx) if multiple bags used for sample interval.

4.3.5 Procedure for placing samples in bags

This procedure should include:

a) double bag all samples (in tough {i.e. >60um} plastic bags);

b) include a sample tag with sample number in outer bag;

c) seal bag as air tight as possible with tape or cable ties;

d) weigh and record all bagged samples;

e) keep samples in shady or cool area if possible;

f) transfer all samples to cold or cool storage at end of day if possible;

g) consider using a bar code system for identifying all samples.

4.3.6 Procedure for storing and despatching samples

This procedure should include:

a) pack sample bags into larger poly sacks (<25kg) or 200 l drums (see Figure 1);

b) seal securely (cable ties, staples, tape or secured lid);

c) label outside with project name, borehole name, sample numbers and bag/drum number with a water proof pen or paint;

d) keep physical or digital record of all sample bags/drums with contents;

e) transfer all samples to cold or cool storage awaiting despatch if possible;

f) samples should be dispatched to the laboratory as soon as reasonably possible (recommend at least once per week);

g) prior to despatch, the laboratory should be informed in writing of the number, identification and dispatch weight of all samples and numbers of drums and or bags that is to be delivered; a copy of the sample record sheets shall be provided to the laboratory;

h) record date of despatch; and