

Methods for analysis and testing of coal and coke —

Part 111: Determination of abrasion index of coal

ICS 73.040;75.160.10

National foreword

This British Standard is the UK implementation of ISO 12900:1998. It supersedes BS 1016-111:1993 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee SFI/3, Analysis and testing of coal and coke, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the ISO title page, page ii, pages 1 to 8 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Amendments issued since publication

Amd. No.	Date	Comments

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Hard coal — Determination of abrasiveness

Houille — Détermination de l'abrasivité



Reference number
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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 12900 was prepared by Technical Committee ISO/TC 27, *Solid mineral fuels*.

Annex A of this International Standard is for information only.

Descriptors: Solid fuels, fossil fuels, coal, pit-coal, abrasion, tests, determination, abrasiveness.

Introduction

The abrasiveness of coal is recognized as a factor in coal operations, from mining to utilization, requiring a standard method of measurement and evaluation, as some coals are more abrasive than others.

The interaction between coal and conveying, storage and crushing equipment results in component wear. In particular, the higher contact pressures in some coal pulverizers result in significant wear.

For the ranking or relative comparison of the abrasiveness of coals, a test was developed [1] which standardized the following equipment variables:

- a) test equipment dimensions and tolerances;
- b) speed of rotation of wearing components;
- c) properties of the wearing components;
- d) mass of the test portion;
- e) top particle size of the test portion;
- f) duration of the test.

The abrasiveness of coal is generally a function of two factors: the physical properties of the coal, in particular moisture content, mineral content and mineral characteristics [1], [2], [3], [4], [5], [6]; the mechanics of the operations to which the coal is subjected.

NOTE Moisture contents over 10 % in the test sample after air-drying and laboratory equilibration may give anomalous results; the reason for this has not been established.

Wear on coal-pulverizing elements in industrial mills is influenced by the physical characteristics of the coal and its mineral constituents, the mechanical characteristics of the mill, including the milling pressures, alloy material properties and coal feed flow, and the operation of the mill.

Abrasiveness as determined by this International Standard has been demonstrated to provide initial empirical estimates of specific wear rates in certain types of industrial tube-ball mills, vertical spindle mills and high-speed hammer mills [3], [6], with different coefficients for each mill type.

Abrasiveness as determined by this International Standard may be of value in providing an initial estimate of the likely wear in other applications, giving the relative effect of different coals.

1 Scope

This International Standard describes a method for determining the abrasiveness of hard coal.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 589:1981, *Hard coal — Determination of total moisture*.

ISO 1988:1975, *Hard coal — Sampling*.

ISO 3310-1:1990, *Test sieves — Technical requirements and testing — Part 1: Test sieves of metal wire cloth*.

ISO 6507-1:1997, *Metallic materials — Vickers hardness test — Part 1: Test method*.

ISO 9411-1:1994¹⁾, *Solid mineral fuels — Mechanical sampling from moving streams — Part 1: Coal*.

3 Principle

Four standard steel blades are rotated under specified conditions in a 2 kg mass of prepared coal in a test machine. The abrasiveness is calculated from the mass of steel lost during the test.

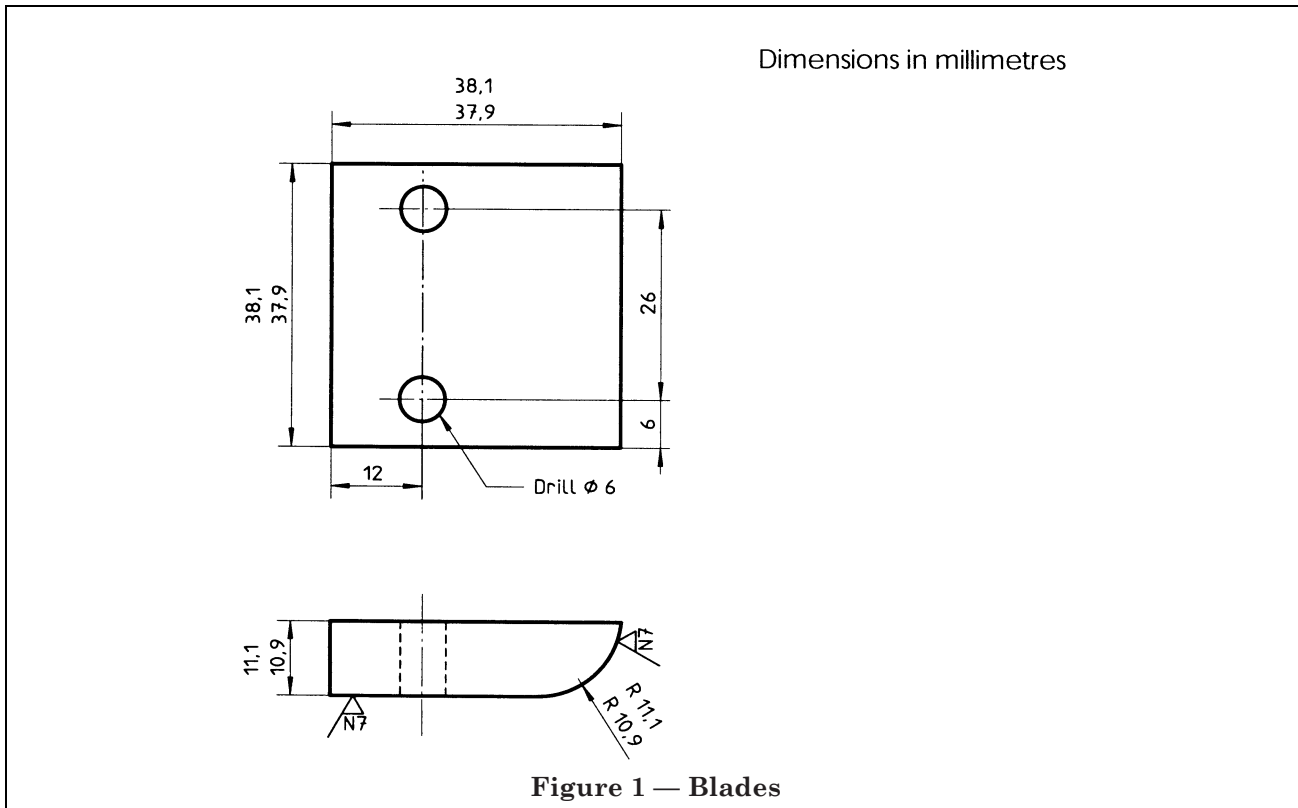
4 Apparatus

4.1 Abrasion test machine, comprising the following components:

- a) *Blades*, of the following types:
 - 1) *A set of four reference blades*²⁾, having a Vickers hardness of 160 ± 15 when tested in accordance with ISO 6507-1. When new, the blades, machined with the bar rolling direction parallel to the line of the bolt holes, from a bar of carbon steel, shall have the shape, dimensions and surface finish shown in Figure 1. To reduce the extent of varying hardness near the surface, care should be taken during machining to minimize surface distortion and heating of the blades. The blades shall be marked for identification.

¹⁾ To be revised as ISO 13909.

²⁾ Suitable blades are available from Mitsui Babcock Energy Ltd., Technology Centre, Renfrew, U.K.



A new set of blades shall be “run in” by carrying out a number of abrasiveness determinations on 2 kg test portions of the same coal until constant results (within the limits of repeatability, see clause 9) are obtained.

When blades are not in use, they should be wrapped in a cloth containing a rust-preventive solution and stored in a desiccator. Immediately prior to use, the blades should be cleaned with a suitable solvent, e.g. methylated spirits, and allowed to air dry in a desiccator.

The reference set of blades shall be discarded when any of the following conditions occurs:

- the wear on the leading edge or corners is greater than 3 mm;
- the blades cannot be correctly adjusted in the jig.

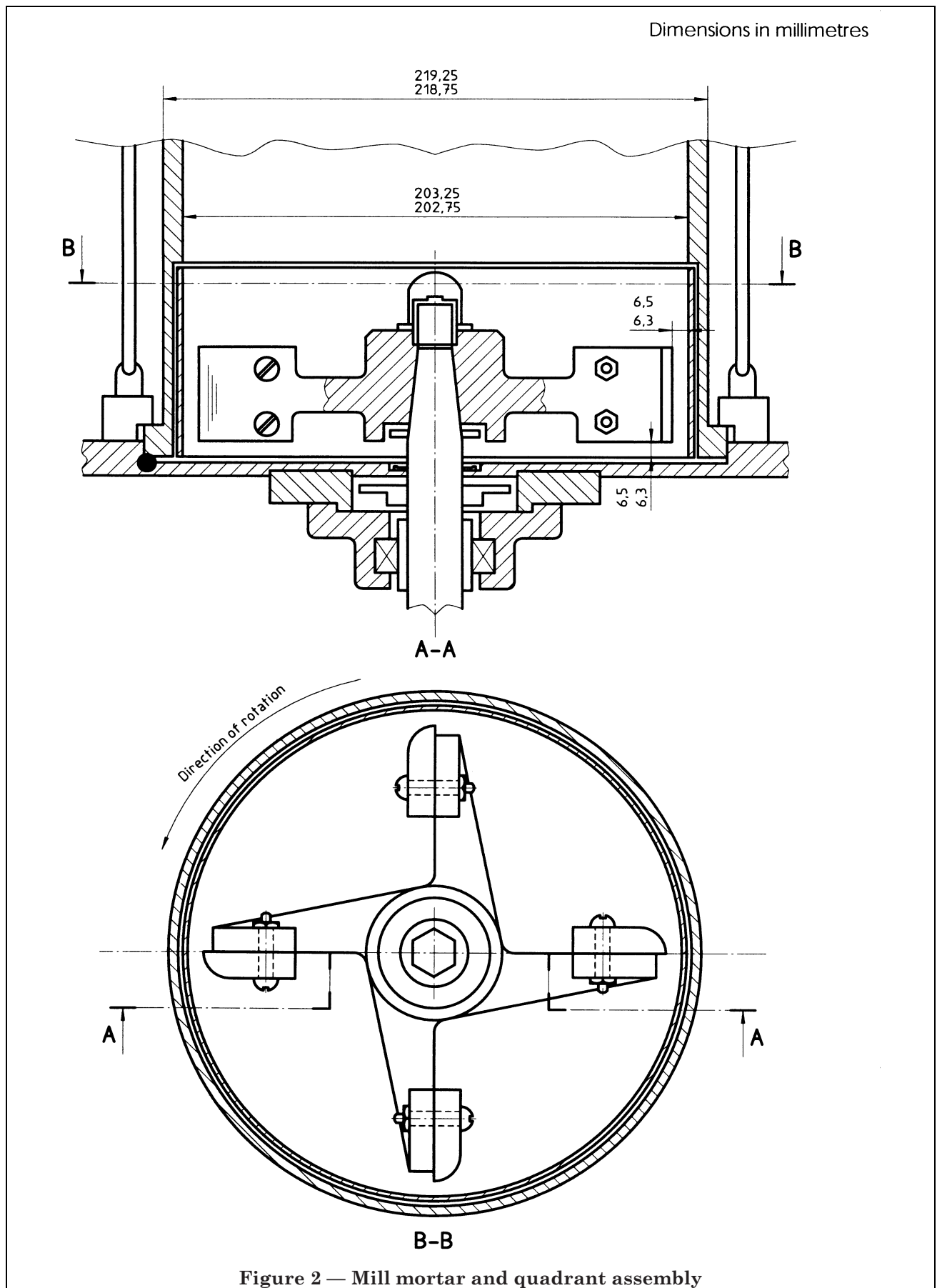
After a number of tests, the wearing surface of the blades may become rough, in which case each blade should be gently polished with a fine-grained emery paper and reconditioned prior to further use.

2) A set of four working blades, conforming to the requirements of 4.1 1) and checked successively against the reference blades when their original mass has decreased by 2 %, 3 % and 4 %, or more frequently if required.

The working set of blades shall be discarded when the results obtained on a sample using the working set differ, after a minimum of three determinations, by more than the limit of repeatability from the value obtained using the reference set.

After a number of tests, the wearing surface of the blades may become rough, in which case each blade should be gently polished with a fine-grained emery paper and reconditioned prior to further use.

b) *Mill mortar*, having dimensions as shown in Figure 2 and fitted with a dust-tight cover. The lower sections of the walls may be recessed to accommodate a replaceable liner. Hardened metal or hard metal plate is recommended for the mill mortar (or liner if fitted). The mill mortar shall be discarded (or a new liner fitted) when the tolerance shown in Figure 2 is exceeded.



c) *Quadrant*, having four arms with elongated bolt holes for attachment and adjustment of the blades using round-head bolts, nuts and spring washers. The quadrant shall be capable of being removed from the mill mortar (see Figure 2).

NOTE Some test machines have quadrants which are not removable. For these machines the blades should be adjusted using suitable gauges so that the trailing and bottom edges are positioned $6,4 \pm 0,1$ mm from the wall and bottom of the mill mortar.

d) *Drive*, for driving the quadrant at $24,5 \text{ s}^{-1} \pm 0,5 \text{ s}^{-1}$ either directly or indirectly by a constant-speed electric motor. The shaft shall be fitted with a revolution counter and automatic cut-off switch.

NOTE A 2,5 kW motor is suitable. The drive may be above or below the mill mortar.

e) *Jig*, metal, (see Figure 3) to assist in attaching and adjusting the blades to the quadrant arms. The jig dimensions shall be such that, when the blades are secured on the quadrant arms so that they are touching the walls and bottom of the jig, they will have the correct clearances when the quadrant is replaced in the mill mortar. The clearance (6,3 mm to 6,5 mm) between the blades and the mill mortar shall be checked periodically using a limit gauge.

4.2 *Balance*, capable of weighing a mass of not less than 2 kg to within 1 g or better.

4.3 *Balance*, capable of weighing the blades to within 0,1 mg.

4.4 *Jaw crusher*, capable of reducing coal particles to less than 6,7 mm with minimum production of fines.

4.5 *Test sieves*, having apertures 6,7 mm, 16 mm and 31,5 mm, and conforming to the requirements of ISO 3310-1.

4.6 *Fine brass brush*, for cleaning blades.

5 Sample preparation

The test sample shall be of 6,7 mm nominal top size and shall have a fines content of not more than 30 % less than 1 mm.

The sample shall be taken in accordance with ISO 1988 or ISO 9411-1 and be prepared in accordance with ISO 9411-1.

A suitable procedure, as shown in the flow diagram in Figure 4, is as follows:

The sample is prepared to give 55 kg or more of material having a nominal top size of 31,5 mm. It is then air-dried.

The air-dried sample is sieved using a 16 mm sieve. The fraction passing this sieve is set aside, and the retained material is crushed (in one or more steps) to pass a 16 mm sieve.

If required, the sample of coal less than 16 mm may be divided, but to no less than 20 kg.

The sample is then sieved using a 6,7 mm sieve. The fraction passing this sieve is set aside, and the retained material is crushed (in one or more steps) to pass a 6,7 mm sieve.

All the minus 6,7 mm coal is collected together and thoroughly mixed.

The sample is exposed in a thin layer for the minimum time necessary for the moisture content to reach equilibrium with the laboratory atmosphere.

6 Procedure

Inspect the mill mortar, quadrant arms and blades and, if necessary, clean with a suitable solvent. Dry in a desiccator and weigh each blade to the nearest 0,1 mg.

NOTE A suitable solvent is methylated spirits.

Position the quadrant in the jig. Attach the blades to the quadrant using round-head bolts, nuts and spring washers. Ensure that the blades are just touching the walls and bottom of the jig and that the blades are mounted with the curved edges facing the direction of rotation. Tighten the nuts securely and check the adjustment. If necessary, adjust the blades.

Weigh out a $1,5 \text{ kg} \pm 0,01 \text{ kg}$ sample and determine the total moisture content in accordance with ISO 589. Carry out the moisture determination concurrently with the abrasiveness determination.

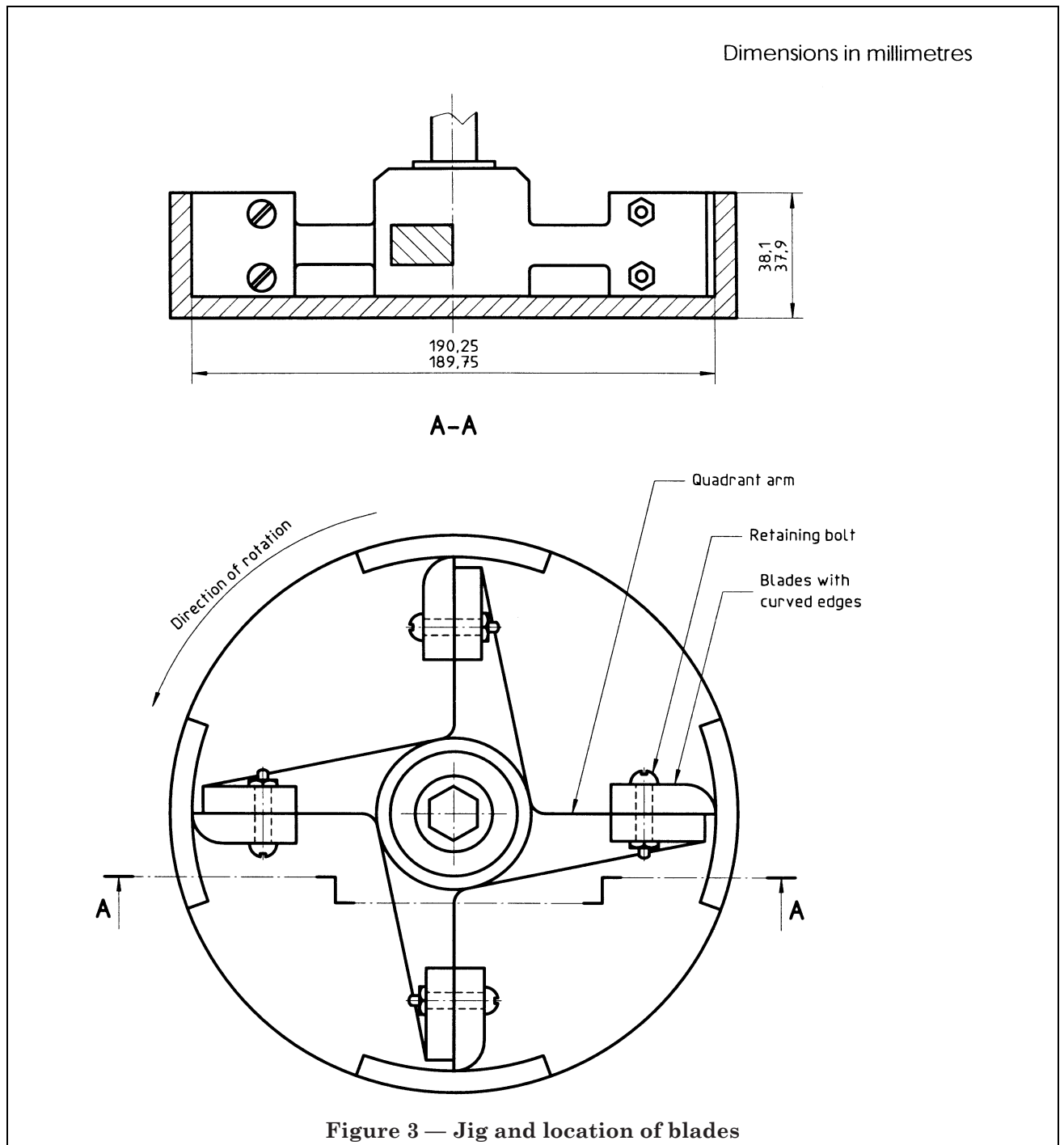
Weigh out a $2 \text{ kg} \pm 0,1 \text{ kg}$ test portion. Place the quadrant and blades in the mill mortar. Place the 2 kg test portion in the mill mortar and level the surface. Fit and secure the cover. Set the automatic counter, start the motor and allow it to trip at $12\,000 \text{ revolutions} \pm 20 \text{ revolutions}$.

Remove the cover and the coal from the mill mortar. Remove the quadrant assembly and check that the blades are correctly positioned by replacing the quadrant and blades in the jig. If the blades have moved, repeat the entire test procedure with fresh test portions of coal, ensuring that the blades are firmly secured.

Remove the blades, allow them to cool and carefully clean them using the brass brush and a suitable solvent. Dry the blades and store in a desiccator until ambient temperature is reached. Re-weigh each blade to the nearest 0,1 mg.

NOTE If the loss of mass of one blade repeatedly deviates by 20 % relative or more from the average loss of mass of all blades, the test should be discarded and the reason investigated.

Repeat the test using a duplicate test portion.



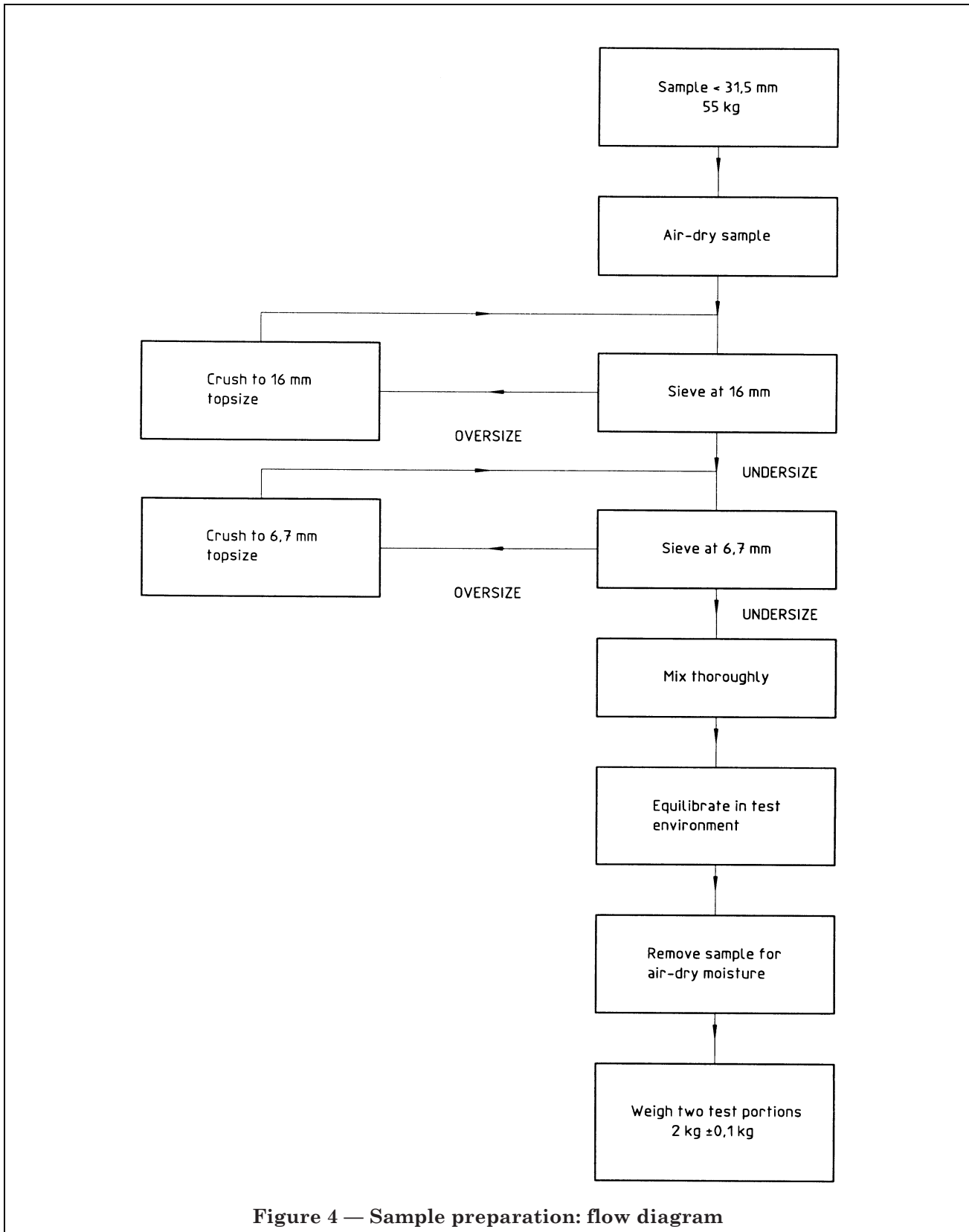


Figure 4 — Sample preparation: flow diagram

7 Calculation

The abrasiveness of the coal, A , in milligrams of metal lost per kilogram of coal, is calculated using the following equation:

$$A = \frac{(m_1 - m_2) \times 10^3}{m_3}$$

where

- m_1 is the total initial mass, in grams, of the four blades;
- m_2 is the total final mass, in grams, of the four blades;
- m_3 is the mass, in kilograms, of the test portion.

8 Reporting of results

Report the result as the mean of duplicate determinations to the nearest whole number.

9 Precision of the determination

The numerical values for repeatability and reproducibility should not exceed those given in Table 1.

Table 1 — Precision data for the determination of the abrasiveness of hard coal

Abrasiveness observed	Repeatability r	Reproducibility R
≤ 20	2	See Note
> 20	10 % of mean	See Note

NOTE As the test result is a function of the air-dried moisture in the test portion (among other factors), a value for reproducibility cannot be quoted. A series of international interlaboratory tests have failed to generate highly reproducible results for this test.

10 Test report

The test report shall contain the following information:

- a) identification of the sample;
- b) a reference to this International Standard and its year of publication (i.e. ISO 12900:1997);
- c) the sample preparation procedure used;
- d) date of the test;
- e) the test result;
- f) the moisture content of the sample after air drying and laboratory equilibration;
- g) any unusual features noted during the determination;
- h) any operation not included in this International Standard or regarded as optional.

Annex A (informative)

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