INTERNATIONAL STANDARD 1953

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Hard coals — Size analysis

First edition 1972-08-01

UDC 662.66 : 620.165.3

Ref. No. ISO 1953-1972 (E)

Descriptors : coal, sieve analysis, size preparation, sampling.

Price based on 16 pages

FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up 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.

Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 1953 was drawn up by Technical Committee ISO/TC 27, *Solid mineral fuels.*

It was approved in July 1970 by the Member Bodies of the following countries:

Canada	Israel	Switzerland
Chile	Italy	Turkey
Denmark	New Zealand	United Kingdom
Egypt, Arab Rep. of	Portugal	U.S.A.
Germany	Romania	U.S.S.R.
Greece	South Africa, Rep. of	Yugoslavia
India	Sweden	

The Member Bodies of the following countries expressed disapproval of the document on technical grounds :

Australia	France
Belgium	Japan

Printed in Switzerland

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Hard coals — Size analysis

1 SCOPE

This International Standard specifies the methods to be adopted for the size analysis of coal by mass, using sieves, and is applicable to all hard coals. Procedures for obtaining the sample are also included.

2 FIELD OF APPLICATION

This International Standard covers sizing tests that may be required on all run-of-mine coals. It is suitable for graded coals which have been separated between specified limits and for coal which has no specified upper or lower limit. Manufactured fuels and coke are excluded.

Pulverized coal is produced by grinding larger coal until a high proportion will pass through the apertures of the finest test sieve. The present test is, therefore, unable to divide pulverized coal into a wide range of fractions and, although the testing procedure may be applicable, the information which it could give on the size analysis of pulverized coal would normally be limited to the determination of the percentage oversize. The sizing of materials which pass through the finest standard sieves is normally carried out by microscopic, sedimentation or surface area measurement methods. This is outside the scope of the present International Standard.

3 REFERENCES

ISO 565, *Woven metal wire cloth and perforated plates in test sieves — Nominal sizes of apertures*. (At present, Draft No. 2193.)

ISO/R 1213, *Vocabulary of terms relating to solid mineral fuels*.

ISO 1988, *Hard coals — Sampling*. (At present at the stage of Draft.)

4 PURPOSE AND USE OF THE ANALYSIS

The object of establishing the size analysis of coal is to ascertain its mass distribution between different size fractions. The results are expressed in terms of the mass of coal remaining on sieves of different apertures.

The test should be of use, amongst other applications, in assessing the yields of products from run-of-mine coals, in providing design data for coal preparation plants, in checking that products from screening plants are within specification and in assessing the performance of coal crushing plant. It should also assist in the selection of coals for particular processes and appliances.

5 DEFINITIONS

The terms used in this International Standard are in accordance with ISO/R 1213.

6 MESH OPENINGS

Test sieve series as accepted or prescribed by ISO Technical Committee 24 shall be used; in particular, reference should be made to ISO 565. The indiscriminate use of square hole and round hole sieves should be avoided and therefore a continuous range of one type is recommended. Approximate conversion from circular to square apertures can be achieved by multiplying the diameter by 0.9, but such a conversion is only valid for rough comparison purposes and, if used, shall be clearly indicated in the results.

It is important that the apertures of the sieves are checked from time to time by the prescribed methods to ensure that the dimensions lie within the tolerance limits given in the relevant ISO publication.

7 SAMPLING FOR SIZE ANALYSIS

7.1 General

The sample for size analysis shall be taken according to ISO 1988. Attention is particularly drawn to clause 2.9 of that document, which refers to special precautions and to alterations to the minimum mass and number of increments which may be necessary when sampling for physical tests. The special provisions and precautions applicable to sampling coal for size analysis are detailed below (see Annex A).

7.2 Reference standards of precision

The size analysis of a sample of coal is determined as a group of percentages by mass of material which has been retained on, between, or has passed a selected series of test sieves and not all these percentages will have the same

precision. Extensive experiments on a wide range of types and sizes of coal have shown that the precision of each of these percentages is related to its own numerical value and to whether it refers to the cumulative material retained on one sieve or the material passing one sieve and retained on a smaller sieve. It is not related to the size or mode of preparation of the coal.

For a given coal the precision will normally be improved by taking more increments; practical considerations, however, limit the number of increments that can be dealt with and it is necessary, therefore, to select a convenient number. The number chosen for the sampling of coal in these recommendations is 40, as it has been shown that the errors due to sieving and sample division tend to offset the increase in precision that may be expected from increasing this number.

The levels of precision in Table 1, therefore, are those which should be obtained when testing the most variable coals. In the majority of cases the precisions obtained will be better (i.e. of smaller numerical value) than those of Table 1 and, when replicate sampling procedures are used, the precisions actually obtained may be checked or calculated.

TABLE 1 – **Reference standards of precision (95 % limits) for size analysis of coal**

a) Cumulative percentage on one sieve

Percentage oversize	Precision
< 5	1.5
5 – 10	2.4
10 – 20	3.8
20 – 30	4.8
30 – 70	5.0
70 – 80	3.4
80 – 90	3.0
90 – 95	2.1
> 95	1.1

b) Percentage between two sieves

Percentage in fraction	Precision
< 5	0.8
5 – 10	1.8
10 – 20	2.7
20 – 30	3.2
30 – 50	3.5

When sampling regular consignments of coal it is recommended that the precision to be aimed for should be twice that given in Table 1 (i.e. half the numerical values given). Special applications such as testing to a specification may require different standards and the method of duplicate sampling will permit the number of increments to be adjusted accordingly. If an increase in the number of increments would result in an excessively large primary sample, it would be advantageous to take replicate samples and thereby improve the mean of the data obtained.

7.3 Minimum mass of increment

ISO 1988 specifies the minimum mass of increment applicable to sampling for moisture and ash, and the provisions of clause 3.3.1, "Principle", are applicable to sampling for size analysis.

7.3.1 *Coals up to 150 mm top size*

Clause 3.3.2, "For coals up to 150 mm, top size", of ISO 1988 is applicable to sampling for size analysis.

7.3.2 *Coals over 150 mm top size*

Clauses 3.3.3 and 3.3.4, "For coals over 150 mm top size", and 3.3.5, "Reduction of inconveniently large increments", of ISO 1988 do not apply to sampling for size analysis, and the following procedures shall be substituted.

The minimum mass of increment, P (in kilograms), shall be determined from the empirical formula

$$P = 7.2 \left(\frac{D}{120}\right)^3$$

where D is the nominal upper size in millimetres.

Larger masses of increments than those given by the formula above shall be taken if, by so doing, the whole width and thickness of the stream can conveniently be sampled in one operation, for instance :

1) stopping the conveyor and either removing all the coal from a length of the belt sufficient to give the minimum mass of increment for the size of coal, or removing all the coal from a length of belt at least two and a half times the maximum size of coal passing, whichever gives the greater mass of increment;

2) taking the whole of the contents of a pit tub or mine car, or of a traxcavator, grab or the like when loading into wagons;

3) taking the contents of a whole bag when sampling a bagged product.

In these circumstances, a very large increment may have to be taken, but it is not permissible, when sampling for size analysis, to subdivide the increment and add part to the sample as may be done when sampling for general analysis.

7.4 Number of increments

The provisions of clause 3.2.2 of ISO 1988 are not applicable to sampling for size analysis and the following procedures shall be observed.

7.4.1 *Single consignments*

The most common problem is to sample a consignment of coal without knowledge of its sampling characteristics. Such a consignment is referred to as a single consignment. The initial number of increments for sampling single consignments, given in Table 2 below, are based on the worst cases encountered in the experimental evidence examined in the preparation of these recommendations and are such that reference standards of precision recommended in Table 1 will be achieved in most cases.

Samples may be taken from a single consignment either in the form of a single sample or as six replicate sub-samples. It is recommended that this latter procedure be followed where possible to enable the precision of the results to be

checked by the method given in Annex C of ISO 1988. In addition, the effects of sieving and sample reduction errors are reduced, so that fewer increments need to be taken.

TABLE 2 – **Initial numbers of increments to be taken when sampling a single consignment**

One sample	40
Six replicate sub-samples	6 X 5

There may be occasions when a different standard of precision from that recommended is required, for example when carrying out efficiency tests. In such cases the user of these recommendations will need to investigate the precision obtained by taking different numbers of increments and adjust his sampling plan to suit the particular requirement.

When sampling single consignments of large coals it is not possible to give the same assurance that the reference standard of precision will be obtained. In most cases the sampling precision will be achieved, but there is a greater risk of under-sampling. For this reason, it is strongly recommended that six replicate sub-samples be taken to check the sampling precision.

7.4.2 *Regular sampling*

When carrying out continuous sampling it is recommended that, to begin with, not less than five increments be taken from each unit to give a total of not less than thirty increments over the sampling period. This procedure will give a reasonable assurance that the period averages will have precisions better than those quoted in Table 1. For intermittent sampling, it is recommended that, initially, thirty increments be taken in each unit. In either case, the number of increments shall be adjusted, using the method given in Annex C of ISO 1988 when the period average is required, or as in clause 7.7 of the present document if the precision of the individual consignments is required.

7.5 Taking, handling and transport of samples

Since the size distribution of coal changes during conveying, screening and loading, it is important to take the sample at the point at which the size analysis is required. If the result of the analysis of a sample is to be representative of the size distribution of the unit of coal from which it has been taken, breakage during the handling and transport of the sample must be reduced to a minimum. The increment should preferably be placed in rigid containers, the contents of the sampling scoop being emptied gently into these containers. The handling of the containers during transport must also be as gentle as possible.

Coal, particularly large coal, is susceptible to breakage, and the methods employed for taking, transporting and sieving the sample will have a marked influence on the size analysis. It is recommended that as each increment is taken the pieces over 40 mm in size should be sieved or gauged at or near to the point of sampling. Similarly, when carrying out a full size analysis, the bias due to breakage can be reduced by the removal by hand of the larger pieces and sieving of the remainder of the sample by hand placing before the coal is transferred to the 40 mm sieve.

When using mechanical samplers, there is danger of breakage of material whilst collecting the sample. Samples taken by a mechanical sampler shall not be used for the determination of the size analysis of coal unless the installation has been checked against hand sampling and the sampler shown to be free of bias, by the procedure of Annex E of ISO 1988, using the size distribution as the variable, contrary to clause E.4.2.

The sampling of stationary coal of over 80 mm top size contained in wagons, ships and stock piles for the determination of size analysis is not recommended. Reliable results can only be obtained by taking the samples during the loading or unloading or putting down or picking up in the case of stock piles, using one of the recommended methods for sampling from a stream of coal.

7.6 Sampling of pulverized coal

The procedures contained in these recommendations may be used for sampling pulverized coal for size analysis when the coal is flowing under the influence of gravity in chutes or at the delivery end of conveyor systems where fluids are not the transport medium. When pulverized coal is transported in suspension in a fluid, iso-kinetic sampling techniques are essential; these techniques are not included in ISO 1988 and are beyond the scope of these recommendations.

7.7 Methods of checking sample precision

When a coal is handled regularly at the point of sampling, it is possible to use the method of duplicate sampling to assess the sampling precision, and consequently to adjust the number of increments taken in future consignments to obtain the precision required. The method by which this is done varies according to the purpose for which the sampling is carried out. In Annex C of ISO 1988 methods are given which can be used when the purpose of the sampling is to obtain the average quality over a period to a specified precision. These methods are equally applicable to the size analysis of the coal and are not repeated here. Care is necessary, however, in applying those methods to very small or very large fractions, i.e. less than 5 % or greater

than 95 %. In such a case the statistical analysis should be carried out on the transformed variable, q, where $q = \sin^{-1}\sqrt{p/100}$, rather than on the actual percentage, p; this function may be obtained from tables, for example in Cambridge Elementary Statistical Tables, Cambridge, 1953.

Sampling for size analysis is, however, often not carried out as regularly as for other properties of coal, although it may be done sufficiently often for the method of duplicate sampling to yield useful results. The emphasis must therefore be on obtaining the results for each consignment to a sufficient degree of precision. An alternative method of examining the results to that given in Annex C of ISO 1988 is given below, to ensure that each sample is taken to a precision of $\pm A$.

Example :

Ten successive consignments or units of coal are sampled in duplicate. Each sub-sample is analysed separately and the results set out as in Table 3.

TABLE 3 – **Size analysis of samples from successive deliveries of coal**

Sample No.	2.8 mm sieve		500 μm sieve	
	Retained (duplicate samples) %	Difference %	Retained (duplicate (samples) %	Difference %
1	74.9 72.9	2.0	92.7 92.6	0.1
2	74.0 74.5	0.5	92.3 93.5	1.2
3	73.1 76.1	3.0	93.8 92.0	1.8
4	70.3 68.5	1.8	88.5 88.8	0.3
5	75.1 76.3	1.2	91.4 92.2	0.8
6	75.9 74.1	1.8	91.8 91.0	0.8
7	73.0 75.1	2.1	92.3 92.8	0.5
8	80.4 78.2	2.2	94.3 91.6	2.7
9	78.8 81.0	2.2	94.0 94.7	0.7
10	74.8 73.8	1.0	92.4 93.0	0.6
Mean retained on sieve	75.0		92.3	
Mean difference between duplicates		1.8		0.9

The results obtained are examined by calculating the values of $0.4A$ and $1.2A$, where A is the standard of precision required, and comparing these figures with the mean difference between sub-samples for each of the size fractions (see Annex B).

If the mean difference between sub-samples is

1) between $0.4A$ and $1.2A$, the correct number of increments has been taken;

2) less than $0.4A$, too many increments have been taken;

3) greater than $1.2A$, too few increments have been taken.

This test shall not, however, be applied to fractions of less than 5 % or more than 95 %.

It may be necessary to take too many increments for some of the size fractions in order to ensure that the required precision is obtained for the other size fractions.

The results given in Table 3 are from records of a regular sampling programme and the standards of precision required are half the numerical values given in Table 1. Using these standards of precision, the values of $0.4A$ and $1.2A$ are as follows :

Fraction	$0.4A$	$1.2A$
retained on 2.8 mm sieve (%)	0.7	2.0
retained on 500 μm sieve (%)	0.4	1.2

The mean differences between duplicates actually obtained fall between the required values and show that the number of increments taken may be accepted as satisfactory.

If it is shown that too many or too few increments have been taken, the number of increments shall be decreased or increased respectively by about 25 %. This will mean that if the fuel is being grossly over-sampled or under-sampled the correction will only be made in steps.

The situation may arise where little improvement in the precision for individual consignments is being obtained after repeated increases in the number of increments. This difficulty is most likely to occur when sample division is involved in the sieving procedure and is due to the errors of sieving and sample division being large in relation to the sampling errors. In these circumstances it may be necessary to accept a lower standard of precision or to attempt to reduce the errors of sample division and sieving, either by sieving the whole of the sub-sample, by splitting it into a number of approximately equal portions of a size convenient for testing, or by carrying out the sample division at a smaller sieve size.

A similar situation may arise in intermittent sampling when attempting to meet the conditions of clause C.3.6 of ISO 1988. In this case it is recommended that the c/d ratio not be used, but that fixed standards of precision for each sample be aimed for. These may conveniently be those recommended in Table 1 of this International Standard, using the test described above.

If the number of increments has to be adjusted, the sampling shall be continued using the new number of increments and the results examined after a further ten samples have been taken. The number of increments shall then be further adjusted or left unaltered, as the results may indicate.

Duplicate sampling shall be continued until two successive sets of ten results indicate no need to change the number of increments. Thereafter duplicate sampling may be discontinued, if required, and only re-instituted to provide periodic checks.

7.8 Sample preparation

7.8.1 *Sample drying*

If the coal is wet, dry the sample sufficiently to prevent fine coal adhering to the larger particles during the sieving operation. Air-drying is the recommended procedure but, for coals containing a large proportion (for example over 20 %) of wet fines (i.e. under 3 mm), the sample may be spread in a thin layer and dried at a temperature not exceeding 50 °C. Allow the coal to cool to room temperature before weighing.[1)]

7.8.2 *Sample division for reduction of bulk*

If the mass of undersize passing a particular screen is more than twice that given in Table 4, it may be reduced by sample division to not less than the figure given.

TABLE 4 – **Minimum mass of undersize to be retained**

Size of coal	Mass kg
Passing through screen of	
40 mm	180
25 mm	70
12.5 mm	16
6.3 mm	2
4.0 mm	1
2.8 mm	0.25

The undersize may be reduced in mass by means of a mechanical sample divider or riffle, provided that size degradation and dust loss is avoided and that the apparatus can be relied upon not to give biased sub-samples; however, division of samples containing material of size greater than 12.5 mm by strip mixing (see Annex C) followed by splitting is recommended to minimise both breakage and bias. Material not included as part of the sub-sample should be weighed, and retained until all analyses and calculations are complete.

Samples of wet or dry fines will generally be larger than is required for the size analysis. Samples of dry fines, after air-drying, if necessary, and mixing, may be reduced to the appropriate mass given in Table 4 by means of a mechanical sample divider or riffle. For wet fines, spread the gross sample on a clean flat surface, form into a cake, 15 to 25 mm thick, and extract a 2 kg sub-sample by taking not less than fifty increments evenly spread over the cake, using a small sampling scoop. If the sample is to be dry sieved, dry the the sub-sample at a temperature not exceeding 50 °C. Allow the coal to cool to ambient temperature[1)]. Mix and reduce to the appropriate mass given in Table 4 by means of a mechanical sample divider or riffle.

The methods of sample division should be checked by the procedure described in Annex D of ISO 1988, to ensure that the variance of sieving and sample division adopted for this specification is not exceeded. The values of this variance are given in Table 5.

TABLE 5 – **Variance of sieving and sample division**

a) Cumulative percentage on one sieve

Percentage oversize	Variance
< 5	0.3
5 – 10	0.9
10 – 20	1.1
20 – 30	2.1
30 – 70	2.4
70 – 80	1.3
80 – 90	0.8
90 – 95	0.3
> 95	0.1

b) Percentage between the sieves

Percentage in fraction	Variance
< 5	0.1
5 – 10	0.5
10 – 20	1.1
20 – 30	1.2
30 – 50	1.0

8 TEST SIEVES

8.1 General

A continuous range of sieves shall be used, such that not more than 5 % remains on the upper size sieve and not more than 5 % passes through the lower size sieve. For intermediate sizes, not more than 25 % should fall between any pair of sieves.

8.2 Perforated plates

The recommended series of test sieves that will normally satisfy the above requirements is 125, 90, 63, 45, 31.5, 22.4, 16, 11.2, 8, 5.6 and 4.0 mm square aperture or equivalent round aperture. If this series is inadequate for the sizing of graded coals, sieves from the supplementary sizes, 100, 80, 50, 40, 25, 20, 12.5, 10 and 6.3 mm, are to be included. For coal over 100 mm in size, single hole perforated plates (gauges) of the required dimensions are used.

The aperture dimensions, plate thicknesses, bridge widths and tolerance limits are given in Table 6.

1) Low rank coals which have been dried at an elevated temperature will pick up moisture during and after cooling. It is necessary to ensure that such coals are in equilibrium with the atmosphere before weighing; this may take several hours.

TABLE 6 – **Perforated plates in test sieves (round and square holes)**

Nominal width of aperture	Plate thickness	Minimum width of any bridge	Screening area (approx.) (square hole)	Aperture tolerances			
				Permissible departure of average aperture size from nominal width of square apertures		Maximum tolerance for any one aperture	
mm	mm	mm	%	%	mm	%	mm
Principal sizes							
125	3.0	17.5	61			0.80	1.00
90	3.0	11	65			0.89	0.80
63	3.0	8.5	62			0.95	0.60
45	2.0	6.0	65			1.11	0.50
31.5	2.0	4.25	62			1.27	0.40
22.4	2.0	2.8	64			1.34	0.30
16	2.0	2.0	64			1.69	0.27
11.2	1.5	1.4	64			2.05	0.23
8	1.5	1.3	57			2.38	0.19
5.6	1.0	1.2	49			2.68	0.15
4	1.0	1.0	44			3.25	0.13
Supplementary sizes							
100	3.0	12.5	64	0.30	0.3	0.85	0.85
80	3.0	10.0	64	0.38	0.3	0.88	0.70
50	3.0	6.50	63	0.40	0.2	1.10	0.55
40	2.0	5.00	64	0.45	0.18	1.125	0.45
25	2.0	3.25	63	0.48	0.12	1.40	0.35
20	2.0	2.50	64	0.55	0.11	1.50	0.30
12.5	1.5	1.80	61	0.72	0.09	1.92	0.24
10	1.5	1.40	61	0.80	0.08	2.10	0.21
6.3	1.0	1.25	51	1.11	0.07	2.70	0.17

8.3 Wire mesh sieves

For the sizing of coal below 6.3 mm size, wire mesh test sieves of square aperture are used. The recommended series is 4, 2.8, 2, 1.4, 1 mm; 710, 500, 355, 250, 180, 125, 90, 63 and 45 μm.

The aperture dimensions, wire diameters and tolerance limits are given in Table 7.

TABLE 7 – **Woven wire cloth in test sieves**

Nominal width of aperture W	Nominal diameter of wire	Aperture tolerances		
		Maximum tolerance for any one aperture ($+ x$ % of W)	Tolerance for average aperture width ($\pm y$ % of W)	Intermediate tolerance $z = \frac{x + \lvert y \rvert}{2}$ rounded up
mm	mm	%	%	%
5.6	1.6	9	3	6
4	1.4	10	3	7
2.8	1.12	11	3	7
2	0.9	12	3	8
1.4	0.71	13	3	8
1	0.56	15	3	9
μm				
710	0.45	16	4	10
500	0.315	18	4	11
355	0.224	20	4	12
250	0.16	22	4	13
180	0.125	24	4	14
125	0.09	29	5	17
90	0.063	33	5	19
63	0.045	40	5	22
45	0.032	49	6	28

8.4 Construction of sieves

For both perforated plate and wire mesh sieves, the material and the overall dimensions of frame and sieving surface and the assembly and nesting of sieves are described in the relevant ISO publication.

For coal over 100 mm in size, plates with single holes (gauges) of the required dimension are used. The perforated plates shall be of mild steel unless the purchaser specifically requests another material.

It is important that the apertures of sieves be checked from time to time to ensure that the aperture dimensions lie within the given tolerances. Sieves with damaged or worn apertures exceeding the maximum tolerances shall have the out of tolerance apertures blanked off or shall be replaced. They shall always be replaced if the blanked off apertures exceed 25 % of the total.

9 SIEVING PROCEDURES

9.1 Choice of procedure

The procedure, or procedures, to be used will depend on the type of sample and the information required – a complete size analysis may be required on a run-of-mine coal or, in the simplest case only the amount of undersize in a graded product. The range of sieves will therefore depend upon the purpose for which the test is made. If the result of the sieve analysis is to be presented graphically, the analysis shall be performed on at least five sieves within the range.

Hand sieving is accepted as the reference standard procedure. Mechanical sieving of the material smaller than 4 mm top size is permissible, provided that the recommended procedure for sieve cleaning and achieving the end point of sieving is applied.

In general, dry sieving is suitable for pulverized coal, untreated smalls and dry fines, whilst wet sieving would normally be used for washed smalls containing fines, particularly where clayey material is present.

In the process of sieving, it may be convenient either to weigh separately each container with its size fraction and to subtract the mass of the empty container or to weigh a container with the fraction of largest size and to add successively all the other fractions, noting the cumulative mass after each addition. The first method is preferred for coals with a top size smaller than 4 mm, so that the end-point of sieving may be checked; the second method is normally used for coals of top size greater than 4 mm.

A preliminary sieving on the finest mesh sieve is recommended when the sample contains a large proportion of very fine material.

9.2 Hand separation

9.2.1 *Equipment*

9.2.1.1 SIEVES AND PERFORATED PLATES, of the required aperture sizes.

9.2.1.2 RECEIVERS.

9.2.1.3 LIDS.

9.2.1.4 WEIGHING MACHINE, sensitive to 0.05 % of the mass of the samples being sieved.

9.2.1.5 TRAYS. Three smooth trays, not less than 400 mm square; glazed paper may be used if trays are not available.

9.2.1.6 BRUSH. A 25 mm flat brush for cleaning the sieves and for brushing the dust from the trays.

9.2.1.7 HARDWOOD BLOCK about 150 mm long with 10 mm square section, for tapping the sieve.

9.2.1.8 WATCH OR CLOCK GLASSES.

9.2.2 *Methods*

9.2.2.1 COALS CONTAINING MATERIAL LARGER THAN 40 mm TOP SIZE.

Weigh the sample. Place the coal on the 40 mm sieve and move the coal by hand or by brush until no more passes through the sieve into an empty receiver placed not more than 150 mm below the sieve. Hand place the residue on the sieve and add any undersize to the receiver.

Re-sieve the oversize as described above, starting with the largest sieve or plate. Collect each fraction in a weighed empty receiver and re-weigh to obtain the mass of each individual fraction.

Sieve the undersize from the 40 mm sieve, as described in 9.2.2.2 below. If the mass of the undersize is excessive, it may be reduced by means of a mechanical sample divider or riffle, provided that size degradation is avoided. If the coal is too large to be passed through a mechanical sample divider or riffle, a sub-sample of suitable mass shall be carefully taken by increments, for example as described in Annex C.

9.2.2.2 COALS SMALLER THAN 40 mm TOP SIZE.

Weigh the sample, place the coal on the largest aperture sieve of the selected series and move the sieve horizontally (with the side of the square sieve holes parallel to the direction of the sieving motion) in such a manner that the pieces of coal are caused to tumble or roll on the sieve.

The motion shall not be stopped by impact and shall be continued for a further eight "to and fro" motions (sixteen total) after the last undersize piece passes through the sieve; the extent of horizontal motion shall not exceed 200 mm.

Place the coal remaining on the sieve in a weighed receiver and re-weigh to obtain the mass of the fraction.

Re-sieve the undersize exactly as described in the preceding paragraphs, down to and including the 4 mm aperture sieve.