BRITISH STANDARD

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Guide to

Determination and presentation of float and sink characteristics of raw coal and of products from coal preparation plants

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Committees responsible for this British Standard

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Association of British Mining Equipment Companies
British Coal Corporation
Coal Preparation Plant Association
Minerals Engineering Society

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Contents

Foreword

This British Standard has been prepared under the direction of the Solid Mineral Fuels Standards Policy Committee. It is based on a draft International Standard, ISO/DIS 7936 which is being prepared by the International Organization for Standardization (ISO).

The results of float and sink tests, presented in tabular and graphical form, are the basis for the provision of washability data and are of use when designing and redesigning coal preparation plants and in predicting, controlling and assessing the performance of such plants. This British Standard provides guidance on float and sink testing, rather than specifying the full methods and the means of presenting the results, because of the various purposes for which the tests might be carried out and the wide range of conditions which might apply. It is essential that, before tests other than those for routine control purposes are to be carried out, detailed information concerning the size ranges and relative density fractions to be examined and the accuracy required is provided in order to establish the scope of the test.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 16, an inside back cover 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.

1 Scope

This British Standard provides guidance on the apparatus and procedures for separation methods, based on differences in relative density, for determining the float and sink characteristics of raw coal and of products from coal preparation plants. It also provides guidance on the presentation, in tabular and graphical form, of the results of such tests.

A procedure using a centrifuge to separate coals with a maximum particle size of less than 1 mm is described in Appendix A. A typical procedure for the treatment and testing of a sample of raw coal is described in Appendix B and some practical hints on float and sink testing are given in Appendix C.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this British Standard the definitions given in BS 3323 and BS 3552 apply, together with the following.

2.1
top size

the size corresponding to the 5 percentile on the cumulative size distribution curve of a material, i.e. the size above which 5 % of the material is retained

2.2
bottom size

the size corresponding to the 95 percentile on the cumulative size distribution curve of a material, i.e. the size above which 95 % of the material is retained

3 Sampling

3.1 General

Sampling should be carried out in accordance with BS 1017-1.

The mass of the bulk sample, and consequently the degree of accuracy obtained in a float and sink test, may be varied according to the purpose for which the test is being carried out. The three main categories of tests are as follows:

a) investigations of the characteristics of raw coal;

b) comprehensive plant efficiency tests (see clause **4**);

c) plant control tests.

3.2 Raw coal

The mass of the bulk sample should be such that the number of discrete particles in any size fraction is not less than 2 000. A size fraction is defined by the aperture size of the square-hole sieve through which all the particles will just pass and the aperture size of the sieve on which they will all be retained. Examples of size fractions are given in Table 1 together with the recommended minimum mass of each size fraction. The masses will generally be sufficient to ensure that there are at least 2 000 particles in each size fraction for raw coal, but some values have been adjusted to take account of practical considerations.

Table 1 — Recommended minimum mass of raw coal for a given size fraction

Size fraction	Mass of coal
mm	kg
< 250.0 ⩾ 125.0	1 000
< 125.0 ⩾ 63.0	350
< 63.0 ⩾ 31.5	180
< 31.5 ⩾ 16.0	90.0
< 16.0 ⩾ 8.0	33.0
< 8.0 ⩾ 4.0	7.0
< 4.0 ⩾ 2.0	3.0
< 2.0 ⩾ 1.0	1.5
< 1.0 ⩾ 0.5	1.0
µm	
< 500 ⩾ 63	0.5

In order that there is sufficient material for subsequent analysis, each relative density fraction should have a mass of at least 20 g and should contain at least 10 discrete particles. Because some coals give low yields in the intermediate relative density fractions, it may be necessary to take a much larger bulk sample than that based on the recommendations in Table 1.

Other size fractions, replacing or supplementing those in Table 1, may be chosen: the minimum mass for each size fraction will then depend on the number of separations to be made and the quantitative distribution of the components in terms of relative density.

It is better to take a bulk sample which is too large than to risk not having sufficient material. When testing coal that includes the larger sizes in Table 1, the bulk sample may have to be 10 tonnes or more. From a newly opened mine or a trial shaft, and in other similar circumstances, the mass of the bulk sample should always be at least 10 tonnes.

For bore cores it is usually impracticable to obtain the masses recommended in Table 1. For this reason, core plies or sections as large as possible should be selected and sub-division of a crushed ply or section prior to float and sink testing should be avoided.

Both the size distribution and the ash of the raw coal coming from a working coal face or a mine will vary during a shift as well as from day to day. It is essential that the duration of sampling should be long enough to cover such variations.

3.3 Plant products

The minimum mass of clean coal in a given size fraction should normally be 50 % greater than that for raw coal, to ensure that adequate amounts of misplaced material are available.

Since the relative densities of discard, middlings, etc. are greater than that of clean coal, the minimum mass of samples containing these components should be increased proportionately. This will ensure that these samples contain approximately the same number of particles as the corresponding clean coal sample and that consequently a similar degree of accuracy will be obtained in the test.

Samples should be taken as soon as possible after the material leaves the cleaning unit in order to minimize breakage and disintegration. Testing should then commence as soon as possible.

When sampling pulp, the mass of the (dried) solids should meet the recommendations in Table 1. Increments should be taken at regular time intervals over the total cross section of the pulp stream either manually or by mechanical means, using a sampling device having a capacity equal to at least twice the recommended minimum mass of increment. Care should be taken to ensure that none of the sample is lost by splashing.

3.4 Samples for plant control testing

Routine samples should be taken regularly for the purpose of determining the average efficiency of a cleaning plant. They may represent daily, weekly or even longer periods of operation. The mass taken may be less than that based on the recommendations in Table 1, depending on the reason for the test, but if any dispute arises concerning the accuracy of the results then the mass of the sample should meet all the relevant recommendations in **3.2** and **3.3**.

4 Comprehensive plant efficiency tests

A comprehensive plant efficiency test involves a systematic mass balance of all materials entering and leaving the coal cleaning plant. In this case the mass and moisture content of the raw feed, the mass and moisture content "as weighed" of all cleaned products, discard, etc., and the volume and solids content of the effluent will have to be determined.

The mass of all materials is calculated to a uniform moisture basis and the raw coal feed entering the plant and the products leaving the plant are balanced against each other. The efficiency of the cleaning plant is assessed from the actual and theoretical yields and grades. The analysis of the raw coal feed derived by the computation from the masses and analyses of all the products is used for the calculation of the theoretical yields.

When a screen analysis of a plant product is made in connection with a cleaning plant efficiency test, it will be found that there is some material below the nominal bottom size being treated in the cleaning unit. The mass and particle size range of this undersize material should be recorded.

5 Size analysis

The sample should be spread out on an impervious base, preferably under shelter, and allowed to dry sufficiently for sieving purposes. It should then be sieved using a suitable range of aperture sizes. Typical size fractions are given in Table 2. Oversize material may be broken by hand or machine crushed according to the nominal top size required. If applicable, the relevant part of the crusher circuit in a preparation plant may be simulated.

Table 2 — Example of results of size analysis

Size fraction	Mass of size fraction	Cumulative oversize	Cumulative undersize
mm	%	% (*m*/*m*)	% (*m*/*m*)
⩾ 125.0	Nil	Nil	100.0
< 125.0 ⩾ 63.0	11.9	11.9	88.1
< 63.0 ⩾ 31.5	12.1	24.0	76.0
< 31.5 ⩾ 16.0	12.8	36.8	63.2
< 16.0 ⩾ 8.0	15.7	52.5	47.5
< 8.0 ⩾ 4.0	12.5	65.0	35.0
< 4.0 ⩾ 2.0	10.2	75.2	24.8
< 2.0 ⩾ 1.0	7.5	82.7	17.3
< 1.0 ⩾ 0.5	5.6	88.3	11.7
< 0.5	11.7	100.0	Nil
Total	100.0		

The quantity of material passing the 63 mm aperture sieve is usually more than the amount required and can be divided before proceeding to the next sieve. Further division may be necessary before sieving on some of the smaller aperture sieves.

NOTE The above sieving process may be preceded by a sample treatment operation designed to simulate particle breakdown which may occur in a coal preparation plant.

If it is not possible to carry out efficient sizing by dry sieving due to fine particles adhering to larger particles, then wet sieving should be used to ensure that the fine particles are collected in the appropriate size fraction.

6 Pilot testing

Pilot testing is frequently carried out on a smaller sample in order to determine the pattern of behaviour which the bulk sample will follow. This knowledge enables the operator to plan the actual test in such a way that unnecessary operations are avoided so that the test is carried out more quickly and with less effort.

The pilot test, or previous experience, may indicate an advantage in commencing the separation at either the highest or lowest relative density. A sample which will give a high yield at either of these points should be separated at the point so that the bulk of the sample can be removed in one operation.

In cases where there is only a low yield in one or both of two consecutive relative density fractions in the pilot test, it is better to combine these fractions in the main test. Such a combination will not affect the outcome of the test and will often improve its accuracy and reduce the time and effort involved.

7 Float and sink testing

7.1 Float and sink medium

7.1.1 *Basis for selection*. The medium which is to be used for the separation may be a mixture of organic liquids, aqueous solutions of inorganic salts, or solids in aqueous suspensions. The choice of medium is governed to some extent by the bulk and particle size of the coal being tested, its rank, its relative density and the purpose for which the separation is being carried out. The most suitable range of relative densities[1)] for the test will have to be determined by trial and error but would normally include 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9 and 2.0. Relative densities lower than 1.3 and higher than 2.0 may be required. Additional separations at intermediate relative densities will be found useful if the cumulative ash is increasing rapidly in relation to the cumulative yield for successive relative density fractions. As stated in **3.2**, each relative density fraction should weigh at least 20 g and should contain at least 10 discrete particles.

If it is known or suspected that the sample will disintegrate or otherwise react on contact with water or aqueous solutions, separations will have to be carried out using organic liquids. However, the fact that the raw coal will react with water will affect its behaviour in the cleaning process and any information which will provide guidance should be obtained for reference purposes.

7.1.2 *Organic liquids*. If the separation is critical, particularly for finer particle sizes, the use of organic liquids is preferred because of their low viscosity, their volatility and their inertness towards shales. Some organic liquids and their physical properties are listed in Table 3.

WARNINGS

a) Many solvent vapours are toxic and present a serious health hazard. Adequate ventilation, preferably down-draught (see Figure 3), is essential. Avoidance of contact with the skin is also essential.

b) Mixtures of air and light petroleum vapour are highly explosive.

c) Some organic liquids may affect subsequent analyses.

For relative densities of 1.6 and lower, mixtures of tetrachloroethylene and one of the less dense liquids may be used. For relative densities of 1.6 to 2.9, mixtures of tetrachloroethylene and one of the more dense liquids may be used.

The following equation may be used for determining the volume of liquid required in formulating a mixture of the desired relative density.

$$V_m = \frac{V_t\,(d_t - d_p)}{d_m - d_p}$$

where

V_m is the volume (in litres) of the liquid with the higher relative density;

V_t is the volume of mixture desired (in litres);

d_m is the higher relative density (of one component);

d_t is the desired relative density of the mixture;

d_p is the lower relative density (of the other component).

It is important that the relative density of the resultant mixture is checked, for example by means of a hydrometer graduated in divisions of not more than 0.002.

[1)] All relative densities quoted in this standard are measured at 20 °C in relation to water at 20 °C.

Table 3 — Typical physical properties of organic liquids used in float and sink testing

Organic liquid	Relative density at 20 °C	Distillation range or boiling point at 100 kPa[a]	Viscosity at 20 °C	Vapour pressure at 20 °C	Flammable
		°C	mPa·s	kPa	
White spirit	0.77	30 to 200	—	—	Yes
Light petroleum	0.73	37 to 185	0.548	25.33	Yes
Toluene	0.87	110.7	0.588	2.93	Yes
Kerosine	0.75	165 to 230	1.365	0.11	Yes
o-Xylene	0.88	144.4	0.810	0.68	Yes
m-Xylene	0.86	139.0	0.620	0.85	Yes
p-Xylene	0.86	138.4	0.648	0.92	Yes
Bromoform	2.79	150.0	2.152 (15 °C)	0.60	No
1,1,2,2,-tetrabromoethane	2.96	239.0	12.0	0.01	No
Tetrachloroethylene	1.61	120.8	1.0	1.83	No

[a] 1 kPa = 1 kN/m^2.

Organic liquids are expensive but are frequently preferred to aqueous solutions because the products of the separation are easier to deal with and prolonged washing and drying times are unnecessary because of the volatility of the solvents. They should be used sparingly and solvent recovery should be practised, particularly by drainage, after the coal is removed from the separation tank.

7.1.3 *Inorganic solutions*. Inorganic solutions may often be used in place of organic liquids, but not if any portion of the sample is liable to disintegrate in water to an extent which will affect the accuracy of the test.

For size fractions finer than 8 mm, because of viscosity effects on the separation process, longer separation times are necessary and the quantity of material immersed at any one time has to be controlled in order to achieve complete separation.

Zinc chloride is a commonly used inorganic salt, but it has several disadvantages which should be considered carefully. Zinc chloride solutions are corrosive, hence care should be exercised in the choice of the container used in the test and contact with the skin should be strictly avoided. Further-more, the pores of the material under test frequently become permeated by the zinc chloride solution which is difficult to remove even by prolonged washing with fresh water. The presence of residual zinc chloride may introduce errors in mass and may also affect the analysis of the ash. If contamination by zinc chloride is likely to affect any of the coal analysis results, a measure of the level of zinc chloride in the wash water may be established by means of, for example, a colorimetric determination.

7.1.4 *Solids in aqueous suspension*. Insoluble material with a medium to high relative density and the correct particle size distribution may be used to give a relatively stable suspension of low viscosity. Examples of suitable materials are given in Table 4.

The materials listed in Table 4 can all be used separately or in mixtures. Bentonite may be added to stabilize a suspension. For separations at relative densities greater than 1.5, ground shale and froth flotation tailings will require the addition of material of higher relative density to avoid viscosity problems.

Two important advantages of aqueous suspensions are that they are non-toxic and non-volatile, thus fume extraction is not required. Provided the separated fractions are washed thoroughly with water to remove adhering medium, the properties of the material under test will not be affected. Aqueous suspensions should not be used for separation of size fractions finer than 4 mm.

It is important to be able to accurately determine the relative density of a suspension. A suitable apparatus, which should be calibrated with water at 20 °C, is shown in Figure 1.

7.2 Apparatus

The principal criteria are that the apparatus should be unaffected by the liquids used and convenient to use.

Examples of suitable types of apparatus are shown in Figure 2 to Figure 5.

The apparatus for separating the float fraction from the sink fraction may consist of a basket with a movable partition to allow the two fractions to be dealt with simultaneously while keeping them separate. Alternatively, a tank with a fine mesh base and another tank, which the first tank fits inside, form a useful means for recovering floats and sinks separately. In this latter arrangement, the floats are skimmed off the liquid surface using a fine mesh scoop and the sinks are recovered by raising the inner tank and draining off the liquid.

7.3 Procedure

7.3.1 *Basic techniques*. The separation tank is partly filled with the medium and the relative density of the medium is then checked using a suitable hydrometer. The actual relative density of the medium should be adjusted to the correct value, if necessary, and frequent checking should be carried out to ensure that it is maintained within 0.002 of the desired relative density throughout the separation.

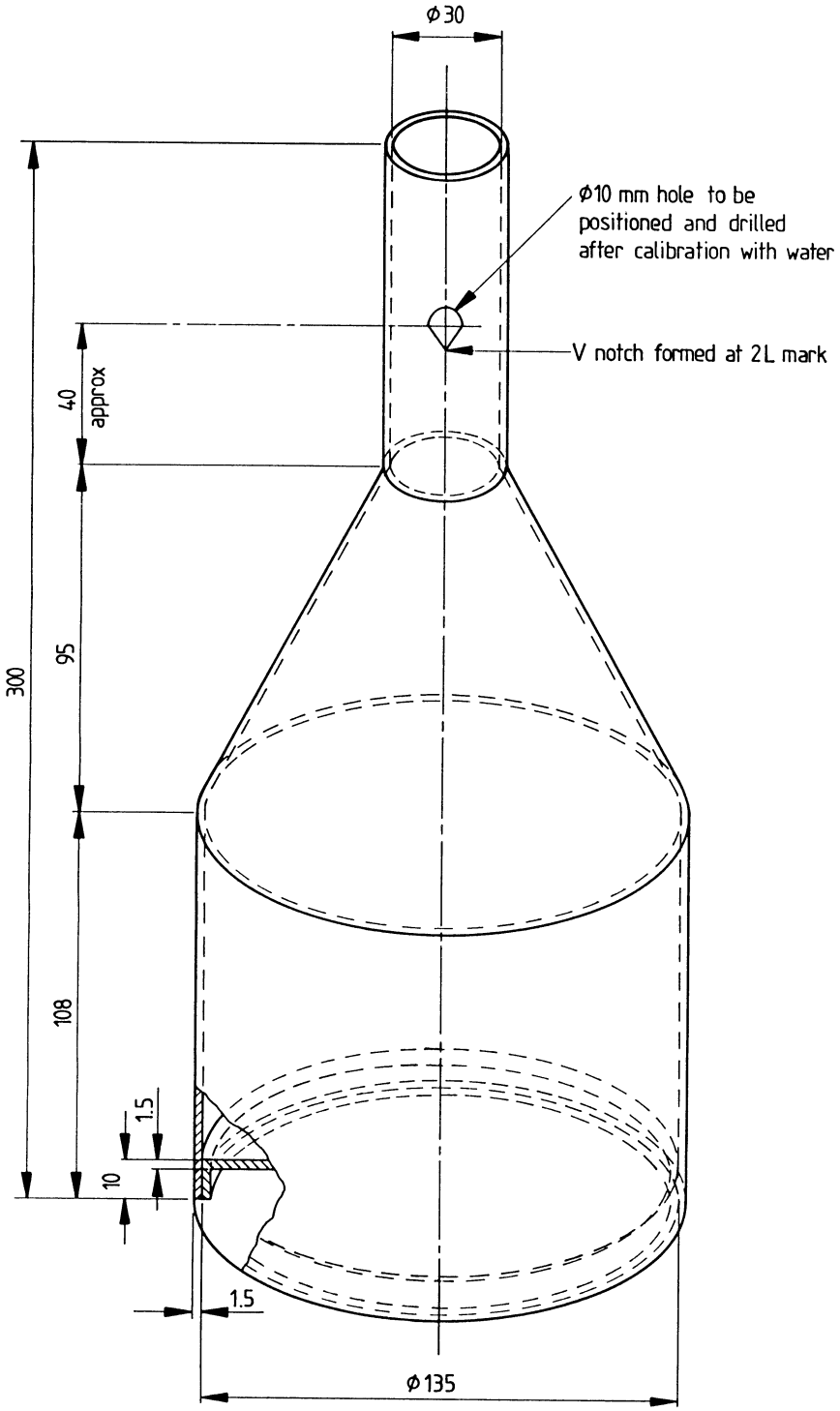
A portion of the size fraction under test, sufficient to form a thin layer, is introduced into the tank containing the medium and gently agitated. Care should be taken not to overload the tank as this might interfere with the separation. After allowing sufficient time for separation, the float material is removed and collected on a draining platform or tray. The settled sink material is then agitated to release any entrained float material, a further portion of the size fraction is introduced and the separation process is continued until all of the size fraction has been separated. The time required for separation will vary according to the type of medium used and the particle size of the material under test. The time required for the separation of material finer than 1 mm particle size can be reduced by using a centrifuge, as described in Appendix A.

The separation process is repeated at different relative densities, in an appropriate sequence, until all of the size fraction has been separated. The various sequences are described in **7.3.2** to **7.3.5**.

The whole process is repeated until all the size fractions have been separated at all the relative densities used.

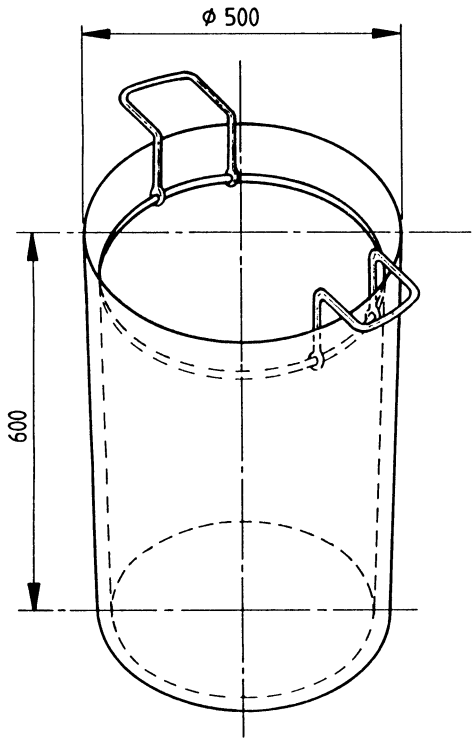
Table 4 — Suitable solids for aqueous suspensions

Material	Relative density	Nominal top size μm	Comments
Finely ground shale	2.4 to 2.6	250	Discard from a coal preparation plant or brickwork shales
Froth flotation tailings	2.4 to 2.6	250	—
Barytes	3.7 to 4.1	63	Commercial barium sulphate
Magnetite	5.0	38	As used in coal preparation plants
Ferrosilicon	6.0	38	Ground or atomised. An alloy containing 85 % iron and 15 % silicon

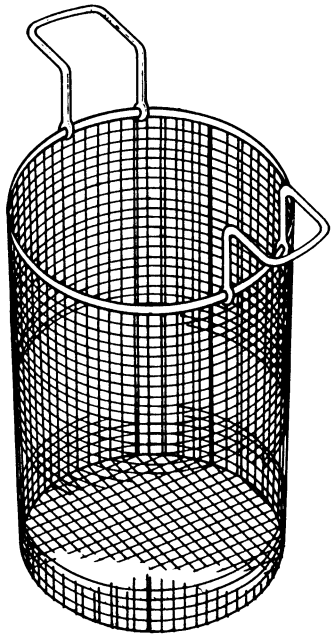


NOTE The vessel should be constructed from brass and all joints should be brazed.
All dimensions are in millimetres

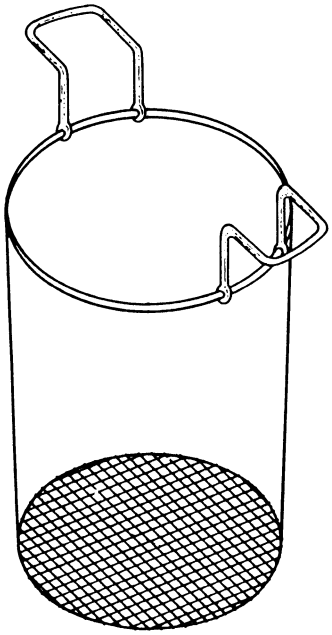
Figure 1 — Sectional elevation of a 2 L measuring vessel for the determination of relative density of solids in aqueous suspension



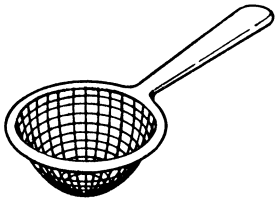
(a) Cylindrical tank with inner liner



(c) Cylindrical inner liner with wire mesh sides and bottom

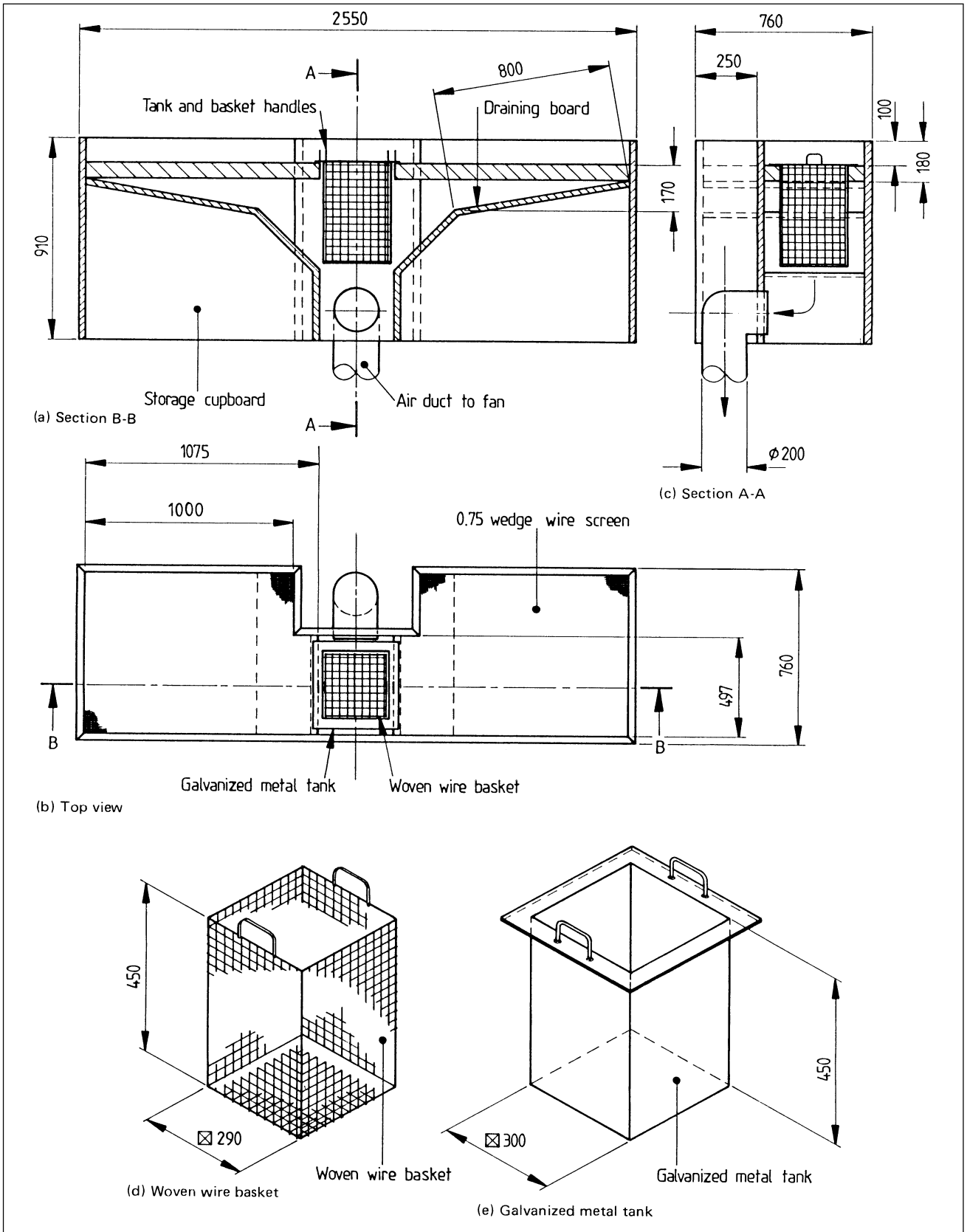


(b) Cylindrical inner liner with wire mesh bottom only



(d) Woven wire mesh strainer

Figure 2 — Suitable cylindrical float and sink apparatus for separation of coarse size fractions



All dimensions are in millimetres.

Figure 3 — Float and sink bench

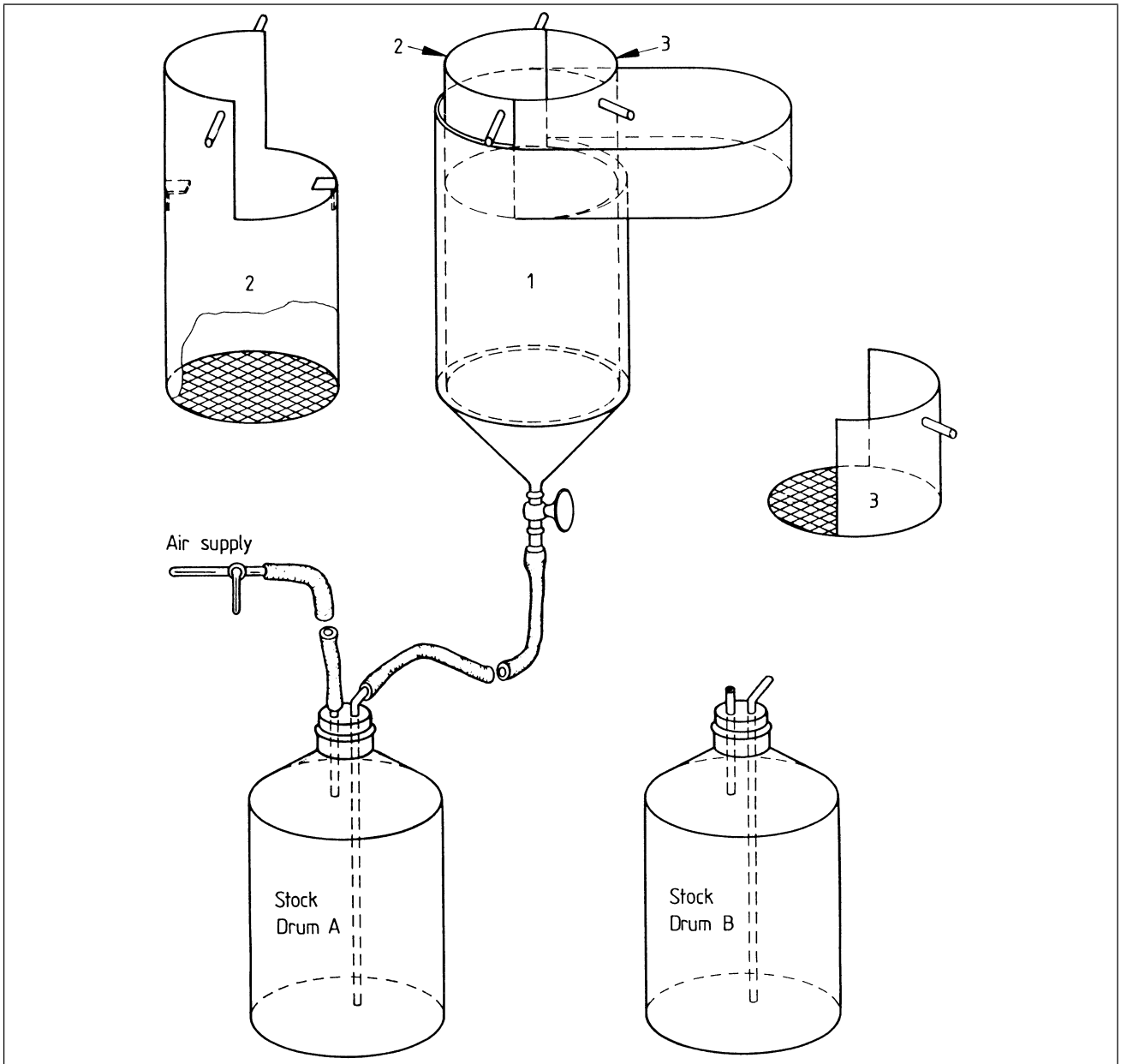


Figure 4 — Suitable float and sink apparatus for separation of 4 mm to 0.5 mm size fractions

7.3.2 *Testing in ascending order of relative density.* This sequence is used when it is known from pilot testing or previous experience that most of the sample is of low relative density. The process described in **7.3.1** is started using the medium of lowest relative density. The float material is washed free of medium, if necessary, dried in air, weighed and, when required, prepared for analysis. The sink material is well drained, to ensure that the relative density of the next medium is not altered, and it is then introduced into the medium of next higher relative density and the separation process is repeated.

In this manner a large proportion of the material under test is removed at the first separation, thereby reducing breakage and handling.

7.3.3 *Testing in descending order of relative density.* This sequence is used when it is known from pilot testing or previous experience that most of the sample is of high relative density. The process described in **7.3.1** is started using the medium of highest relative density. The sink material is washed free of medium, if necessary, dried in air, weighed and, when required, prepared for analysis. The float material is well drained, to ensure that the relative density of the next medium is not altered, and it is then introduced into the medium of next lower relative density and the separation process is repeated.

Again, this sequence means that a large proportion of the misplaced material (this time having a high relative density) is removed at the first separation, thereby reducing breakage and handling.

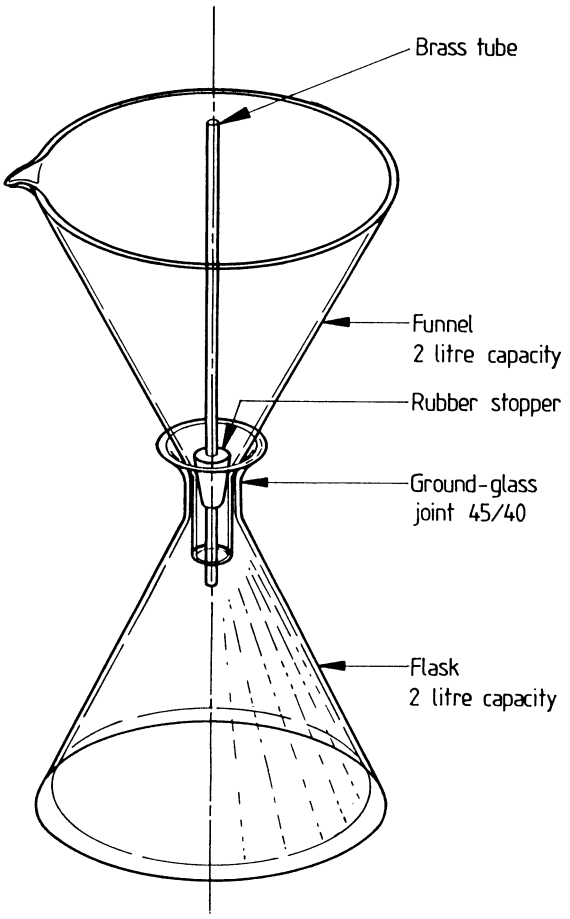


Figure 5 — Suitable float and sink apparatus for separation of size fractions finer than 0.5 mm

7.3.4 *Testing samples containing only small proportions of material with intermediate relative densities*. When it is known from pilot testing or previous experience that most of the sample is material of low relative density and material of high relative density, with little material of intermediate relative densities, the process described in **7.3.1** is started using the medium of lowest relative density. The float material is washed free of medium, if necessary, dried in air, weighed and, when required, prepared for analysis. The sink material is well drained and then introduced into the medium of highest relative density. After separation, as described in **7.3.1**, the subsequent sink material is washed free of medium, if necessary, dried in air, weighed and, when required, prepared for analysis. The remaining float material will now be of relatively small mass and can be further separated in either order of relative densities, as described in **7.3.2** or **7.3.3**.

7.3.5 *Testing samples containing large proportions of material with intermediate relative densities*. When it is known from pilot testing or previous experience that most of the sample is material of intermediate relative densities, the process described in **7.3.1** is started using a medium of intermediate relative density such that the split into float material and sink material is approximately even. The float material is then treated as described in **7.3.3** and the sink material is then treated as described in **7.3.2**.

8 Presentation of results

8.1 Size analysis

The results of the size analysis may be presented as shown in Table 2.

8.2 Float and sink data

The results of float and sink testing of each size fraction may be presented as shown in Table 5. Initially the results are recorded on the basis of 100 % recovery for each size fraction and then the cumulative float and sink data for the size fraction are calculated from these values. The cumulative data may then be presented graphically in the form of washability curves (see Figure 6 and **8.3**) and/or a M-Curve (a Mayer Curve, see Figure 7).

Similar tables may be prepared and presented graphically for combinations of size fractions, on the size analysis proportional basis. The results of float and sink testing of the products of a cleaning process should be presented in accordance with BS 3620.

8.3 Washability curves

In order to produce full washability curves it is necessary to determine the percentage of ash for each relative density fraction in each size fraction. Other parameters, such as sulphur content and calorific value, may be determined, recorded and presented in the same manner.

Table 5 — Typical presentation of float and sink data and calculation for washability curves

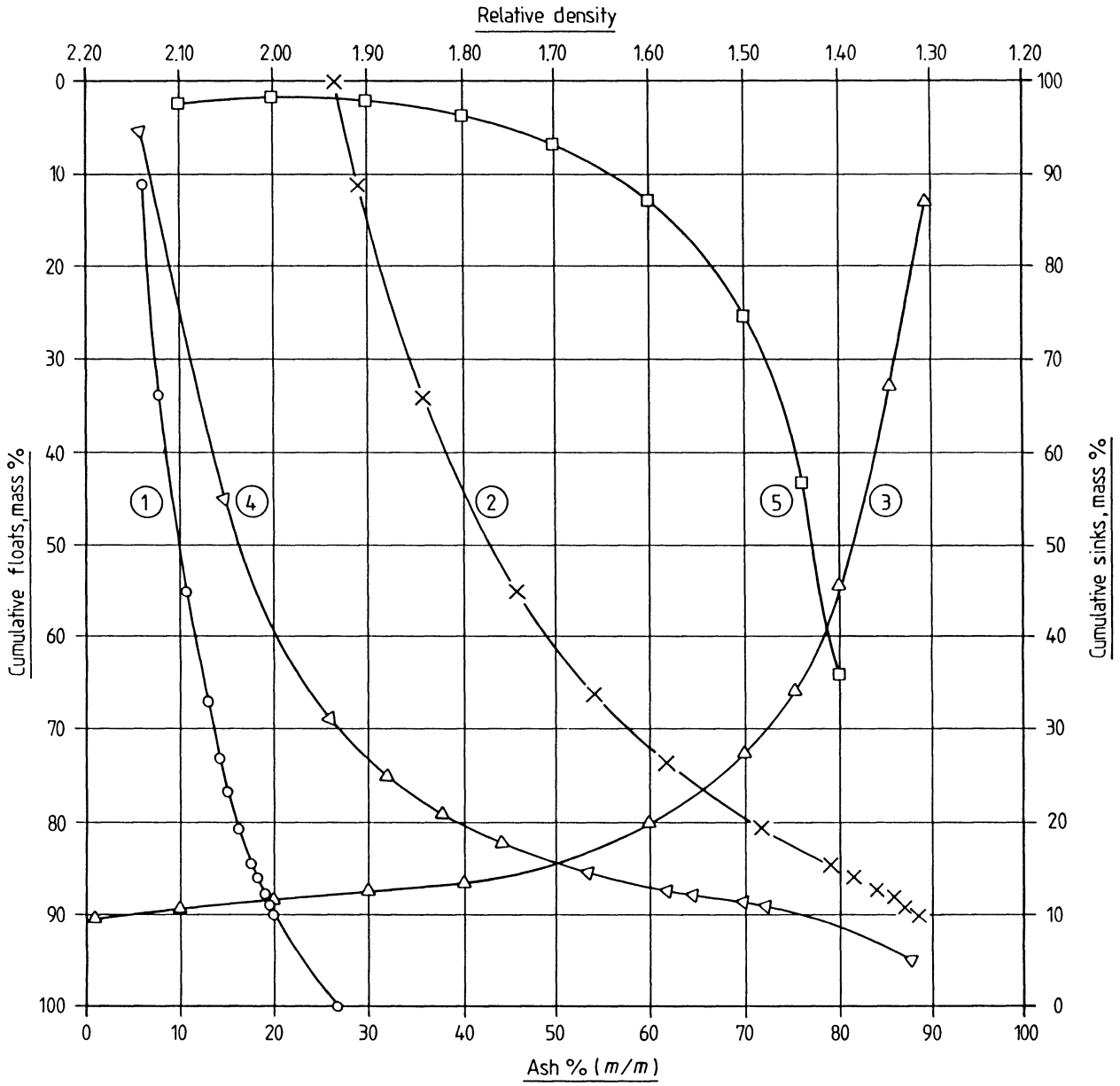
Sample: Coal mine No. 2 shaft ROM
Size fraction: < 31.5 mm ⩾ 16.0 mm
Proportion of total feed: 12.8 %

[1]		[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
Relative density fraction		**Size fraction basis**											
		Mass	**Ash**	**Proportion of ash**	**Relative density**	**Cumulative floats**			**Cumulative sinks**			**Mass**	**Percentage mass of near-density ($d \pm 0.1$) material**[a]
						Mass	**Proportion of ash**	**Ash**	**Mass**	**Proportion of ash**	**Ash**		
				[2] × [3]		Σ[2]↓	Σ[4]↓	$\frac{[7]}{[6]}$	Σ[2]↑	Σ[4]↑	$\frac{[10]}{[9]}$	[6] − $\frac{[2]}{2}$	
Sinks	**Floats**	%	% (m/m)			%		% (m/m)	%		% (m/m)	%	
									100.0	2625.65	26.3	5.5	—
—	1.30	11.0	6.1	67.10	1.30	11.0	67.10	6.1	89.0	2558.55	28.7	22.5	—
1.30	1.35	22.9	8.8	201.52	1.35	33.9	268.62	7.9	66.1	2357.03	35.7	44.4	62.3
1.35	1.40	21.0	14.7	308.70	1.40	54.9	577.32	10.5	45.1	2048.33	45.4	60.5	43.0
1.40	1.45	11.2	20.8	232.96	1.45	66.1	810.28	12.3	33.9	1815.37	53.6	69.7	25.6
1.45	1.50	7.2	26.3	189.36	1.50	73.3	999.64	13.6	26.7	1626.01	60.9	75.1	[b]
1.50	1.55	3.6	32.2	115.92	1.55	76.9	1115.56	14.5	23.1	1610.09	65.4	78.7	11.6
1.55	1.60	3.6	37.3	134.28	1.60	80.5	1249.84	15.5	19.5	1375.81	70.6	82.7	6.3
1.60	1.70	4.4	44.1	194.04	1.70	84.9	1443.88	17.0	15.1	1181.77	78.3	85.9	3.1
1.70	1.80	1.9	53.1	100.89	1.80	86.8	1544.77	17.8	13.2	1080.88	81.9	87.4	1.9
1.80	1.90	1.2	63.4	76.08	1.90	88.0	1620.85	18.4	12.0	1004.80	83.7	88.4	1.3
1.90	2.00	0.7	66.2	46.34	2.00	88.7	1667.19	18.8	11.3	958.46	84.8	89.0	1.8
2.00	2.10	0.6	69.6	41.76	2.10	89.3	1708.95	19.1	10.7	916.70	85.7	89.9	—
2.10	2.20	1.2	72.0	86.40	2.20	90.5	1795.35	19.8	9.5	830.30	87.4	95.3	—
2.20	—	9.5	87.4	830.30		100.0	2625.65	26.3					
Total		100.0	26.3										

NOTE d is relative density

[a] Percentage mass for (d + 0.1) in [6] minus percentage mass for (d – 0.1) in [6]

[b] Not calculable since no data for d = 1.65



(columns refer to Table 5)

Curve 1:	cumulative floats curve	(column 6 plotted against column 8)
Curve 2:	cumulative sinks curve	(column 9 plotted against column 11)
Curve 3:	densimetric curve	(column 5 plotted against column 6)
Curve 4:	characteristic ash curve	(column 3 plotted against column 12)
Curve 5:	near density or difficulty curve	(column 5 plotted against column 13)

Figure 6 — Example of washability curves

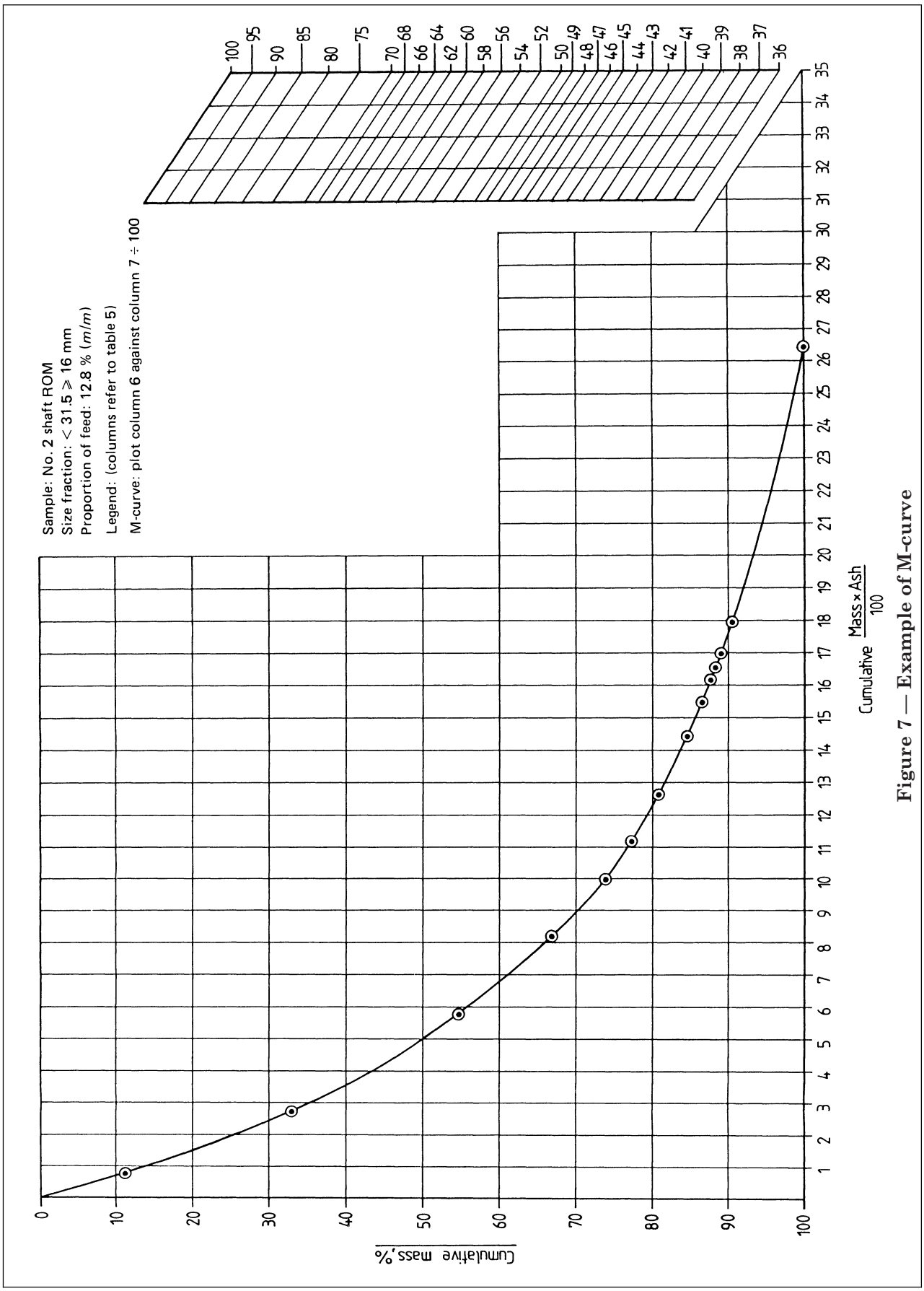


Figure 7 — Example of M-curve

Appendix A Procedure for a centrifugal float and sink test

Divide a representative portion (80 g to 250 g) of the size fraction equally between the test tubes of the centrifuge.

Pour the medium of the lowest relative density into each test tube sufficient to exceed the volume of the solids but not to exceed more than two-thirds of the capacity of the tube.

Mix the contents of the test tube by stirring and adjust the masses of the tubes to a common value by the addition of further medium, if necessary, to achieve balance.

Transfer the tubes to the centrifuge holders and rotate for 10 min at a rotational frequency of 2 000 r/min.

Remove the floating solids from the tubes, taking care not to disturb the sink material. Filter the float material, air-dry and weigh to an accuracy of ± 0.05 %.

Remove the medium from the centrifuge tube along with all the sink material and transfer to a filter. Air-dry to remove the excess medium.

Return the sink material to the centrifuge tubes and repeat the procedure using the medium of next higher relative density.

When separation at all the relative density levels has been completed, remove the final sink material, filter it, air-dry and weigh to an accuracy of ± 0.05 %.

If required, prepare each relative density fraction for analysis.

NOTE More than one representative portion of the size fraction will have to be tested in order to satisfy the recommendations of Table 1. Furthermore, if a relative density fraction is such that less than 20 g are recovered, it will be necessary to test further portions.

Appendix B Typical procedure for the treatment and testing of a sample of raw coal

NOTE 1 It is difficult to lay down a procedure that can be adopted in all cases since coal is such a variable commodity. This procedure may therefore be modified when experience with particular coals indicates that this would be an advantage, while bearing in mind the data which it is hoped to obtain.
NOTE 2 This procedure is illustrated in Figure 8.
NOTE 3 The origin and mass of each fraction should be recorded at each stage.

Obtain the sample in accordance with BS 1017-1, bearing in mind the minimum masses quoted in Table 1.

Spread the sample on a smooth, clean base to air-dry, if necessary, and weigh to an accuracy of 0.05 %.

Sieve on a 63 mm aperture sieve. Weigh the oversize and undersize to an accuracy of ± 0.05 %.

Sieve the 63 mm oversize on the required sizes of sieve. Weigh the fractions to an accuracy of ± 0.05 %. Retain the size fractions for float and sink tests.

Reduce the mass of 63 mm undersize by sample division to the extent that the recommendations of Table 1 can still be met. Weigh the products from the sample division to an accuracy of 0.05 % and retain the excess product as a reserve.

Sieve the divided 63 mm undersize on 31.5 mm and 16 mm aperture size sieves. Weigh the size fractions (< 63 mm ⩾ 31.5 mm) and (< 31.5 mm ⩾ 16 mm) to an accuracy of 0.05 % and retain for float and sink tests.

Weigh the undersize from the 16 mm sieve and reduce the mass by sample division to the extent that the recommendations of Table 1 can still be met. Weigh the products from the sample division to an accuracy of 0.05 % and retain the excess product as a reserve.

Sieve the divided 16 mm undersize on 8 mm and 4 mm aperture size sieves. Weigh the (< 16 mm ⩾ 8 mm) and (< 8 mm ⩾ 4 mm) size fractions to an accuracy of 0.05 % and retain for float and sink tests.

Weigh the undersize from the 4 mm sieve and reduce the mass by sample division to the extent that the requirements of Table 1 can still be met. Weigh the products from the sample division to an accuracy of ± 0.05 % and retain the excess product as a reserve.

Wet sieve the divided 4 mm undersize on 2 mm, 1 mm and 0.5 mm aperture size sieves. Air-dry the (< 4 mm ⩾ 2 mm), (< 2 mm ⩾ 1 mm) and (< 1 mm ⩾ 0.5 mm) size fractions and weigh to an accuracy of ± 0.05 %. Retain the size fractions for float and sink tests.

Allow the < 0.5 mm solids to settle and remove the clear liquor. Weigh the thickened slurry. Agitate vigorously and take representative samples for the determination of solids content and any other tests that may be required.

Further sample division, if necessary, may be carried out on any of the size fractions prior to float and sink testing as long as the required masses can be obtained in each of the relative density fractions.

Test each size fraction above 0.5 mm through the required range of relative densities (see **7.1.1**).

Air-dry the density fractions until all traces of liquid are removed and weigh to an accuracy of 0.05 %. Where heat is applied to assist evaporation, care should be taken such that any subsequent test work is not affected (see BS 1017-1).

Appendix C Practical hints on float and sink testing

C.1 Where material is adhering to large pieces, agitate in water using the basket and container shown in Figure 2.

C.2 Fit baskets and containers with lifting handles (see Figure 2 and Figure 3).

C.3 Wedge wire drainage panels on float and sink benches (see Figure 3) should be hinged or loose laid to facilitate cleaning.

C.4 Where a large mass is to be divided it may be convenient to use the shovel by shovel method, or alternatively as described in **A.2.1.2** of BS 1016-17:1979.

C.5 In wet sieving it may be advantageous to dry sieve first then wash the oversize fraction in a container with water, reallocating the pulp.

C.6 When a down draught bench is not available it is essential to conduct tests using organic liquids out of doors, or alternatively in an open-sided building.

C.7 Air-drying is often more rapid in an open-sided building.

C.8 Petroleum spirit is a more convenient diluent than white spirit.

C.9 Some inorganic salts react exothermically when dissolved in water. Relative density tests should be carried out only when the solution has cooled.

C.10 As it is advisable to restrict the float particles to a thin layer, a wide mouthed vessel saves time in the test.

C.11 To accelerate drying, fractions which have been separated by heavy organic liquids should be washed with a more rapidly evaporating, non-toxic, compatible organic liquid.

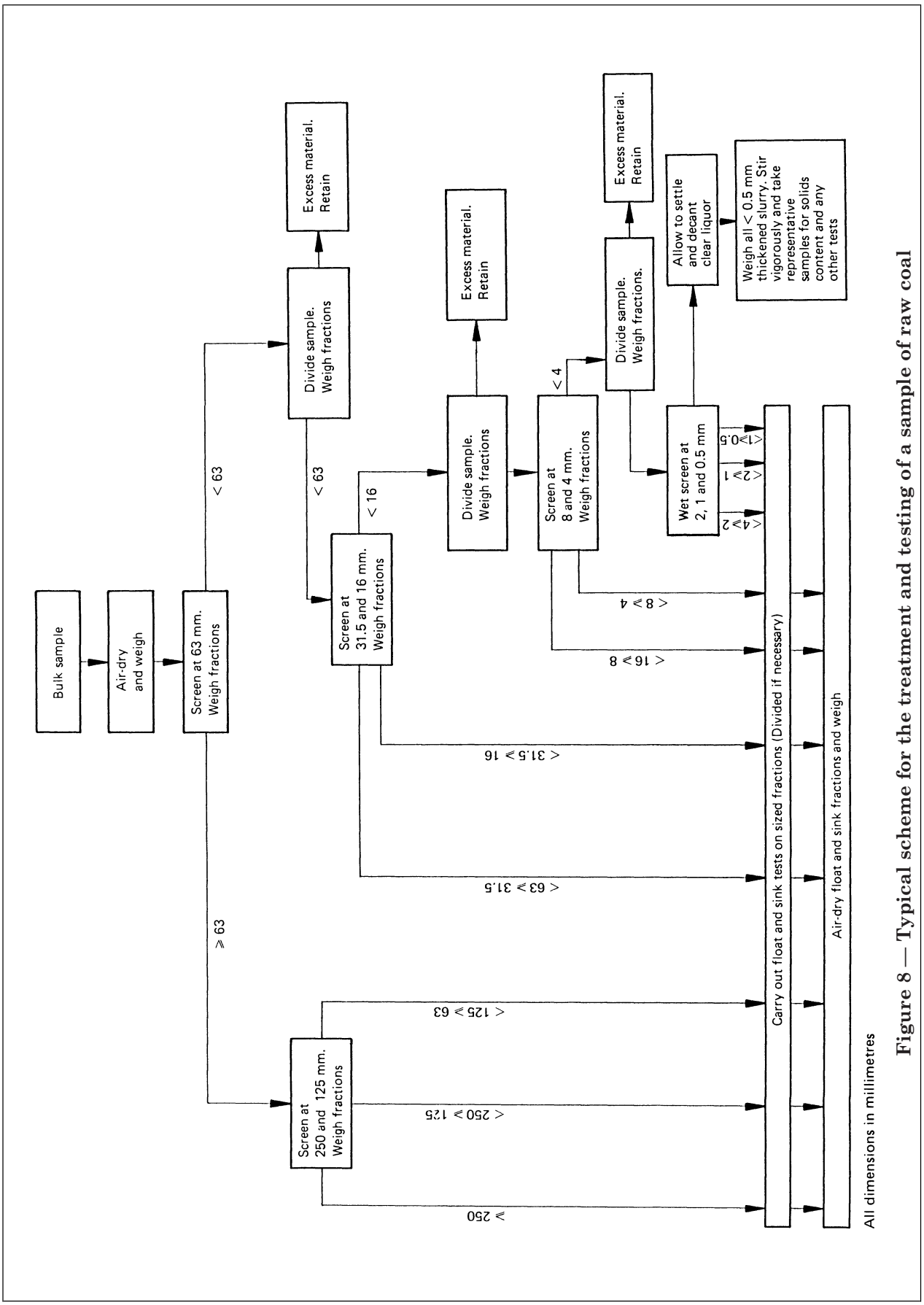


Figure 8 — Typical scheme for the treatment and testing of a sample of raw coal

Publications referred to

BS 1016, *Methods for analysis and testing of coal and coke.*

BS 1016-17, *Size analysis of coal.*

BS 1017, *Sampling of coal and coke.*

BS 1017-1, *Methods for sampling of coal.*

BS 3323, *Glossary of coal terms.*

BS 3552, *Glossary of coal preparation terms.*

BS 3620, *Methods for the expression and presentation of results of coal cleaning tests.*

ISO/DIS 7936, *Coal cleaning tests. General directions for determination and presentation of float and sink characteristics*[2)].

[2)] Referred to in the foreword only.

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