

Methods for

Thermal testing of domestic solid mineral fuel burning appliances with convection —

Part 2: Hood method

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Refrigeration, Heating and Air Conditioning Standards Policy Committee (RHE/-) to Technical Committee RHE/28, upon which the following bodies were represented:

- Association of British Solid Fuel Appliance Manufacturers
- Association of Building Engineers
- British Coal Corporation
- British Flue and Chimney Manufacturers' Association
- Consumer Policy Committee of BSI
- Department of the Environment
- HETAS Ltd.
- Low Temperature Coal Distillers' Association of Great Britain Ltd.
- METCOM
- National Fireplace Council Manufacturers' Association
- Waterheater Manufacturers' Association

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Foreword

This Part of BS 3250 has been prepared under the direction of the Refrigerating, Heating and Air Conditioning Standards Policy Committee, RHE/-, and supersedes BS 3250-2:1961 which is withdrawn.

BS 3250 describes two methods of test for determining the efficiency of appliances which produce part of their useful heat output as convection. Part 1 deals with the flue loss method, in which the total efficiency is obtained by determining the percentage heat content of the flue gases and deducting it from 100 %, making a correction for the undergrate combustible loss. Part 2 deals with the hood method, in which the total efficiency is obtained by adding together the directly measured radiation efficiency, convection efficiency and, for appliances with a boiler, water heating efficiency.

The main technical changes from BS 3250-2:1961 are as follows:

- a) restriction to solid mineral fuels;
- b) metrication;
- c) changes in the test fuel specification covering high temperature coke for roomheaters and low temperature coke for open fires with convection;
- d) inclusion of bituminous coal and anthracite as test fuels for appliances designed primarily to burn these fuels;
- e) modifications to the thermal performance test corresponding to changes in test requirements in BS 3378:1986 for roomheaters and BS 3376:1994 for open fires with convection, including:
 - 1) testing roomheaters at both normal and high draught;
 - 2) the addition of target burning rates for open fires with convection, to cover appliances with tapered and rectangular bottomgrates of 350 mm to 450 mm nominal width, including those designated as suitable for burning bituminous coal with enhanced efficiency;
 - 3) specifying the method of de-ashing open fires with convection according to test fuel;
- f) inclusion of formulae for calculating thermal efficiencies on net calorific value basis.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 34, 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 Part of BS 3250 describes a test method to determine the efficiency of solid mineral fuel burning domestic heating appliances which incorporate as a design feature the production of convected heat. The method is used in the assessment of room heaters and of open fires with convection in accordance with BS 3378:1986 and BS 3376:1994 respectively, to establish whether the minimum efficiency requirements specified in those standards are met.

2 References

2.1 Normative references

This Part of BS 3250 incorporates, by reference, provisions from specific editions of other publications. These normative references are cited at the appropriate points in the text and the publications are listed on the inside back cover. Subsequent amendments to, or revisions of, any of these publications apply to this Part of BS 3250 only when incorporated in it by updating or revision.

2.2 Informative references

This Part of BS 3250 refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

3 Principle

The method is based essentially on the direct measurement of the components of heat output. For the measurement of convection heat output, the convection air from the appliance is collected in an aspirated hood and passed through apparatus where first the temperature rise and then the volume flow of the warm air is determined. The radiation heat output is measured by means of a radiometer. For appliances incorporating a boiler, the water heating output is measured by determining the water flow rate and temperature rise. Then, using the burning rate and calorific value of the test fuel, the component efficiency values are calculated and added together to give the total efficiency.

NOTE The test fuels are specified in Annex A.

4 Definitions

For the purposes of this Part of BS 3250 the definitions given in BS 1846-1:1968, BS 3323:1992, BS 3378:1986 and BS 6100-1.5.1:1984 apply, together with the following.

4.1

normal draught

the natural draught occurring in the test chimney when an appliance is operated to achieve target burning rate

4.2

high draught

an induced draught giving a chimney draught of $0.5 \text{ mbar} \pm 0.2 \text{ mbar}$ in the test chimney when an appliance is operated to achieve target burning rate, to simulate installation of the appliance in a tall chimney

4.3

as charged

a method of expressing fuel consumption in which the mass includes the total moisture present during the firing test

4.4

coal rank code number

a numerical classification index defining a grouping of coals according to rank and caking properties

NOTE See Annex B for the British Coal Corporation classification system for United Kingdom Coals.

4.5

rank

the position of a coal relative to other coals in the coalification series from brown coal (low rank) to anthracite (high rank), indicating maturity in terms of general chemical and physical properties

NOTE Higher ranking is characterized by the increasing proportion of the carbon content and decreasing proportion of volatile matter on a dry, mineral matter free basis.

5 Test equipment

5.1 Test chimney

A test chimney with raised hearth shall be constructed in accordance with Figure 1. The chimney shall terminate inside the test room and a gather shall be provided above the chimney, connected by ducting to a fan discharging to outside air (see Figure 2). Means shall be provided for controlling the draught exerted by the fan on the chimney. For coarse control, the gather shall be capable of being moved up and down and for fine control an adjustable damper or spoildraught shall be incorporated in the ducting.

For testing at normal draught (see 4.1), the gather and damper or spoildraught shall be adjusted prior to the tests so that the chimney draught, measured as described in 5.5, shall be between -0.002 mbar and -0.01 mbar when there is no fire alight and the air in the chimney is at room temperature.

For testing at high draught (see 4.2), the draught shall be adjusted by the method described in 7.3.3.4.

5.2 Convection measurement

5.2.1 General arrangement

5.2.1.1 Inset appliances

Inset appliances are installed for test purposes into a fireplace recess and the convection air from the front of the appliance is drawn into the collecting hood (see 5.2.2.1), which is sited above the appliance. The warm air passes through the temperature measurement section (see 5.2.2.2) attached to the top of the hood and is then ducted to a flow measuring system (see 5.2.3) before being discharged through a fan (see 5.2.4).

5.2.1.2 Freestanding appliances

Freestanding appliances are installed for test purposes within an open-fronted enclosure (see 5.2.5), referred to in this Part of BS 3250 as the enclosure, designed to gather the convection air from all the outer surfaces of the appliance and direct the air into the collecting hood for measurement of temperature and flow by the same means as for inset appliances.

5.2.2 Collecting hood and temperature measurement section (see Figure 3)

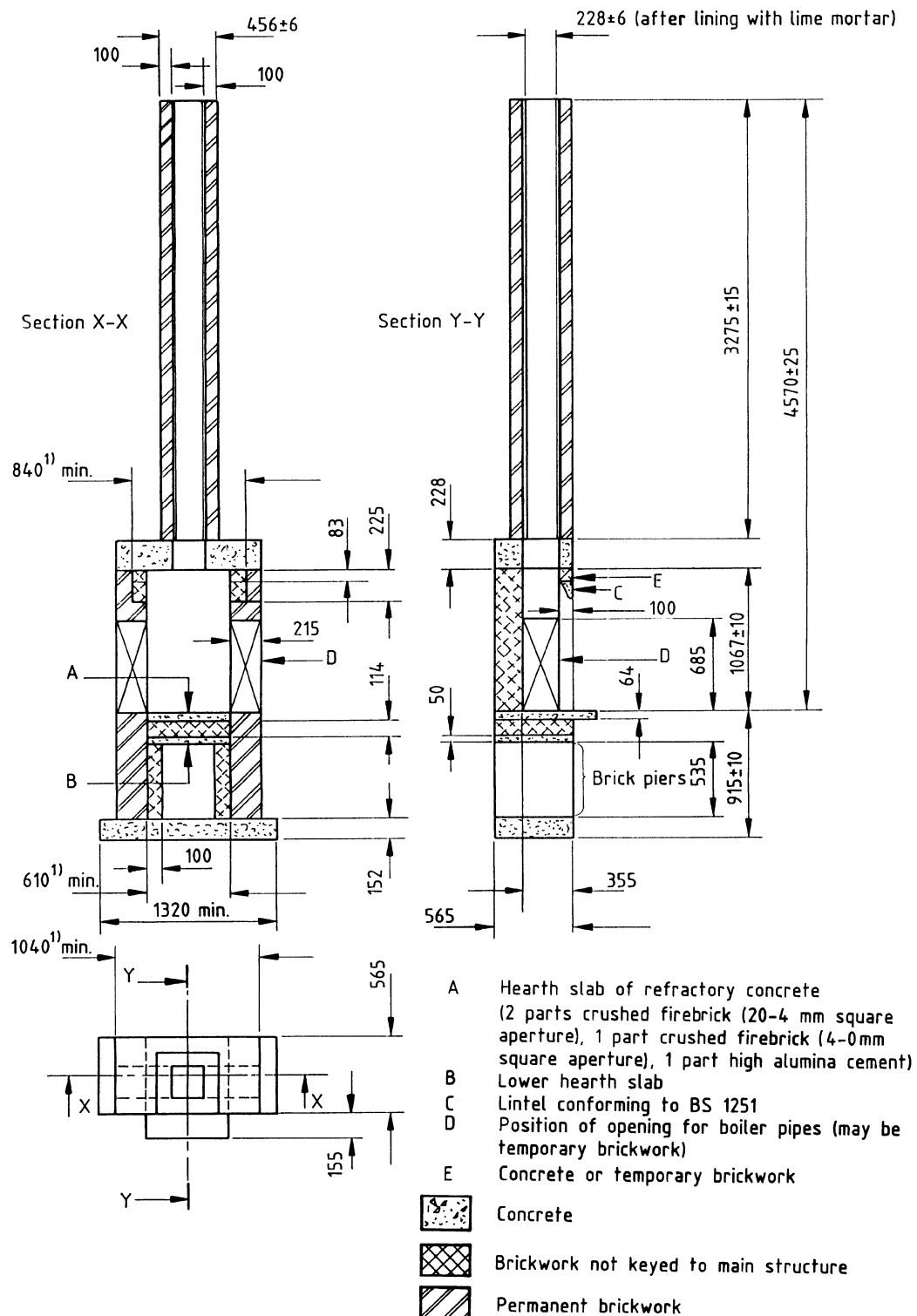
5.2.2.1 Collecting hood

A collecting hood is required of the dimensions shown in Figure 3. The hood is made from aluminium sheet conforming to grade 1200H14 of BS 1470:1987, not less than 1.0 mm thick and with a bright finish. The surfaces inside and outside the hood shall be maintained in a bright condition in use to ensure that radiation is reflected.

The space between the inner and outer skins is evenly packed with glass wool or with other non-asbestos insulating material.

All overlapping metal to metal seams on the hood are coated with a suitable mastic jointing compound, so as to remain substantially airtight.

When the collecting hood is used in conjunction with the test enclosure described in 5.2.5 an extension piece is required, constructed in accordance with Figure 3 and maintained in the same manner as the main body of the collecting hood. Side wings are also required, constructed in accordance with Figure 3, for use when wide appliances are installed in the enclosure.



All dimensions in millimetres. Tolerances are ± 5 mm except where shown.

¹⁾ Add 100 mm to these values for 550 mm appliances.

NOTE The chimney shown is for test purposes and does not relate to modern practice for chimney construction.

Figure 1 — Test setting

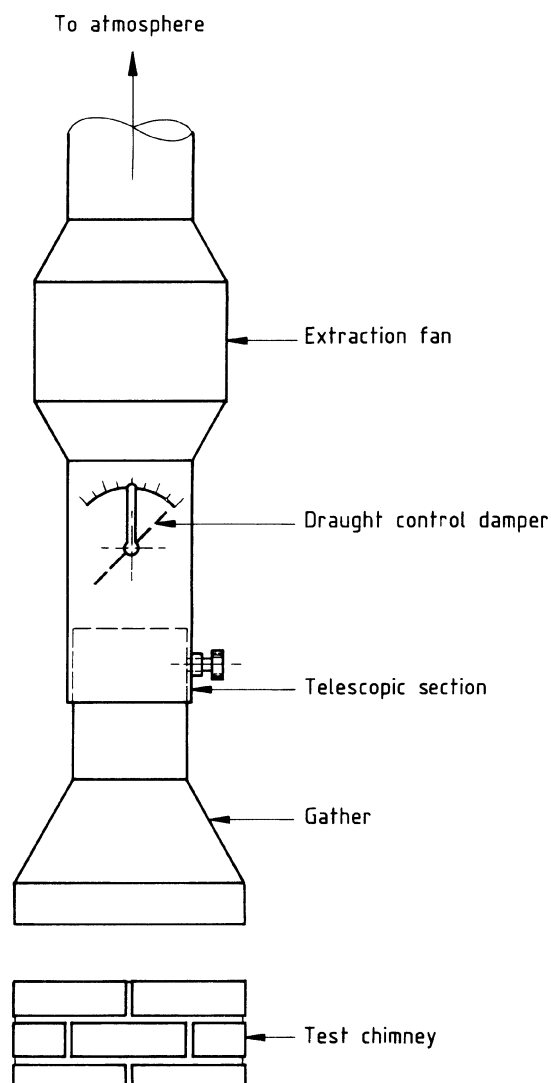


Figure 2 — Flue gas extract system above test chimney

5.2.2.2 Temperature measurement section

A temperature measurement section of the dimensions shown in Figure 3 is required, and is constructed and maintained in the same manner as the collecting hood. It is attached to the top of the collecting hood, to which it is a close fit, to measure the temperature rise above ambient of the warm air drawn into the hood.

Four nickel-chromium/nickel-aluminium thermocouples (see BS 4937-4) shall be used for temperature measurement. They shall be constructed of wire of nominal diameter 0.5 mm or less and connected in series with at least 2 m of sheathed wire between the hot and cold junctions. The hot junctions are inserted into the measurement section through a metal tube of approximately 10 mm internal diameter and positioned across the flue diameter at the locations shown in Figure 3. An airtight seal is made where the wires enter the tube.

The cold junctions of the thermocouples are grouped in pairs on either side of the base of the test appliance (see 6.2.4), to obtain a representative measurement of the temperature of the ambient air drawn over the appliance surfaces.

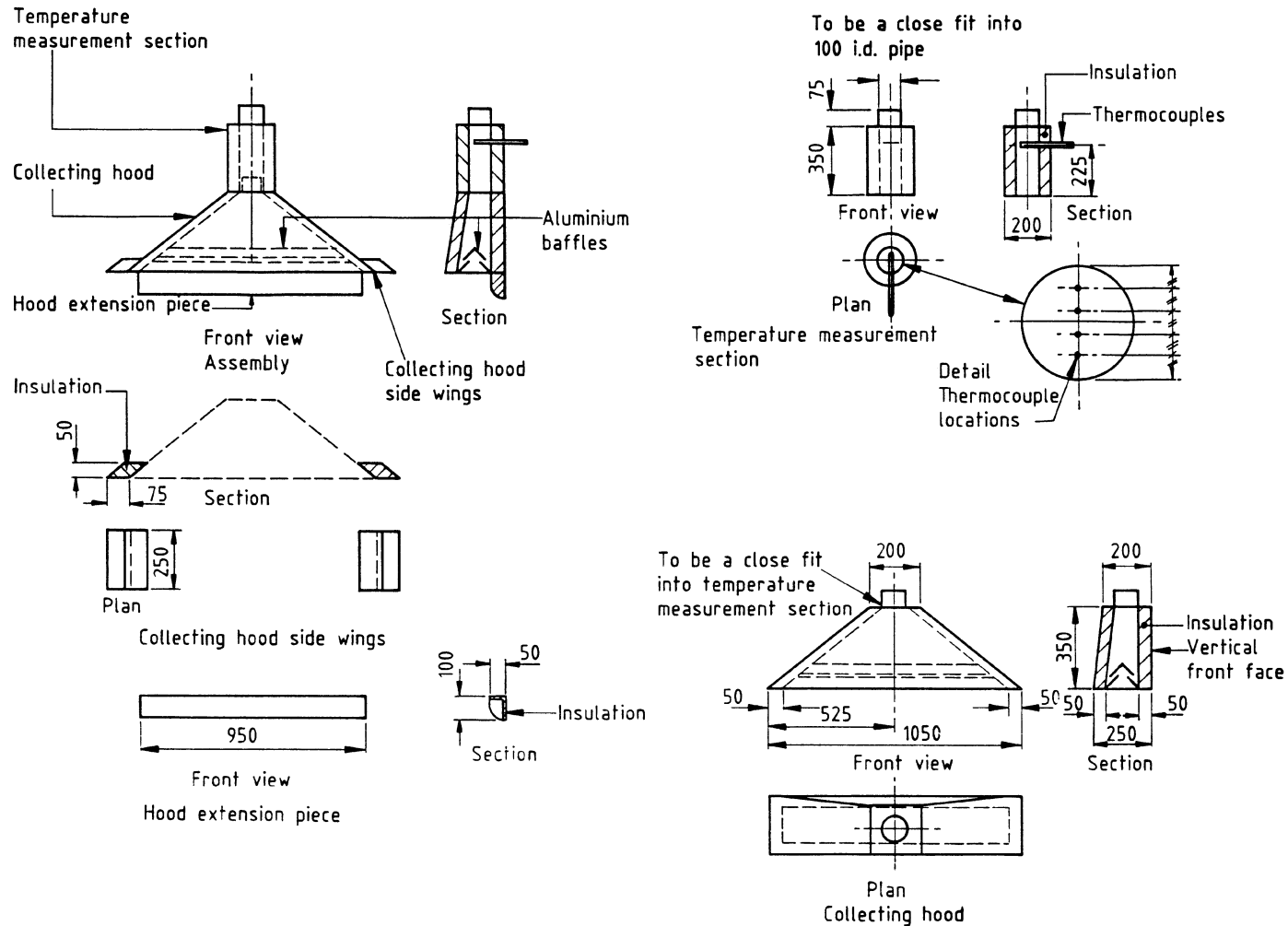


Figure 3 — Assembly and details of collecting hood and temperature measurement section

To shield the cold junctions from radiation, each pair is placed in a metal radiation screen with open ends, made of polished aluminium or material of equivalent reflectivity, approximately 40 mm in diameter, 150 mm long and 2 mm thick.

The assembled four point differential thermocouple shall have a calibration traceable to national standards.

5.2.3 Flow measuring system

For measuring the flow of air through the collecting hood, a flow measuring system capable of measuring air flows in the range 100 m³/h to 650 m³/h with a minimum accuracy of $\pm 3\%$ is required.

NOTE 1 Suitable methods are given in BS 1042.

The flow measuring system shall have a calibration traceable to national standards.

NOTE 2 It is recommended that orifice plates should be used.

A thermocouple is required for measuring the temperature of the air flowing through the flow measuring system. It shall be sited approximately 0.8 m downstream of the measuring system and shall have a calibration traceable to national standards.

5.2.4 Aspirating fan

A fan, capable of extracting 650 m³/h of air at temperatures up to 100 °C and at the same time overcoming a pressure difference of 20 mbar, is required for aspirating the warm air through the collecting hood.

5.2.5 Enclosure for freestanding appliances

A triple-walled open-fronted enclosure constructed in accordance with Figure 4, Figure 5 and Figure 6.

The enclosure is designed so that, with the appliance installed inside the enclosure in the manner described in 6.3, the convection air from all the appliance surfaces is drawn into the collecting hood sited above the front of the enclosure. The innermost walls are blackened and convert the radiated heat from the sides, back and top of the appliance to convected heat.

The walls of the enclosure are made from aluminium sheet conforming to grade 1200H14 of BS 1470:1987, with a bright finish. The two outer walls are fixed 50 mm apart and the innermost wall is adjustable to accommodate appliances of different widths. The air spaces between the side walls are closed at the front by a plate. Alternative central sections in widths of 250 mm and 400 mm provide further adjustment for appliance width.

The top sheets are set back by 250 mm from the adjustable front plates to accommodate the collecting hood.

The innermost walls are painted with a matt black paint on both faces, except for vertical strips approximately 150 mm wide at the front of the side walls. The matt black paint shall be maintained in good condition and the unpainted vertical strips shall be kept bright.

Adjustable plates with a 200 mm diameter hole are provided in accordance with Figure 5 to allow the passage of the flue pipe through the rear or top walls of the enclosure from the different flue outlet positions.

The joints on the flanges of the interchangeable central sections are sealed with a gasket made of mineral wool rope or similar non-asbestos material. Other joints and seams are sealed with a mastic jointing compound, so that there is no leakage between the air streams flowing on either side of the various walls of the enclosure.

5.3 Radiation measurement

A BCURA (British Coal Utilization Research Association) hemisphere cage radiometer¹⁾ fitted with a matched set of radiometer elements is required for measurement of the radiation heat output. The calibration factor F , in kilowatts per millivolt, is initially provided by the supplier of the radiometer and shall be redetermined at intervals not exceeding 24 months.

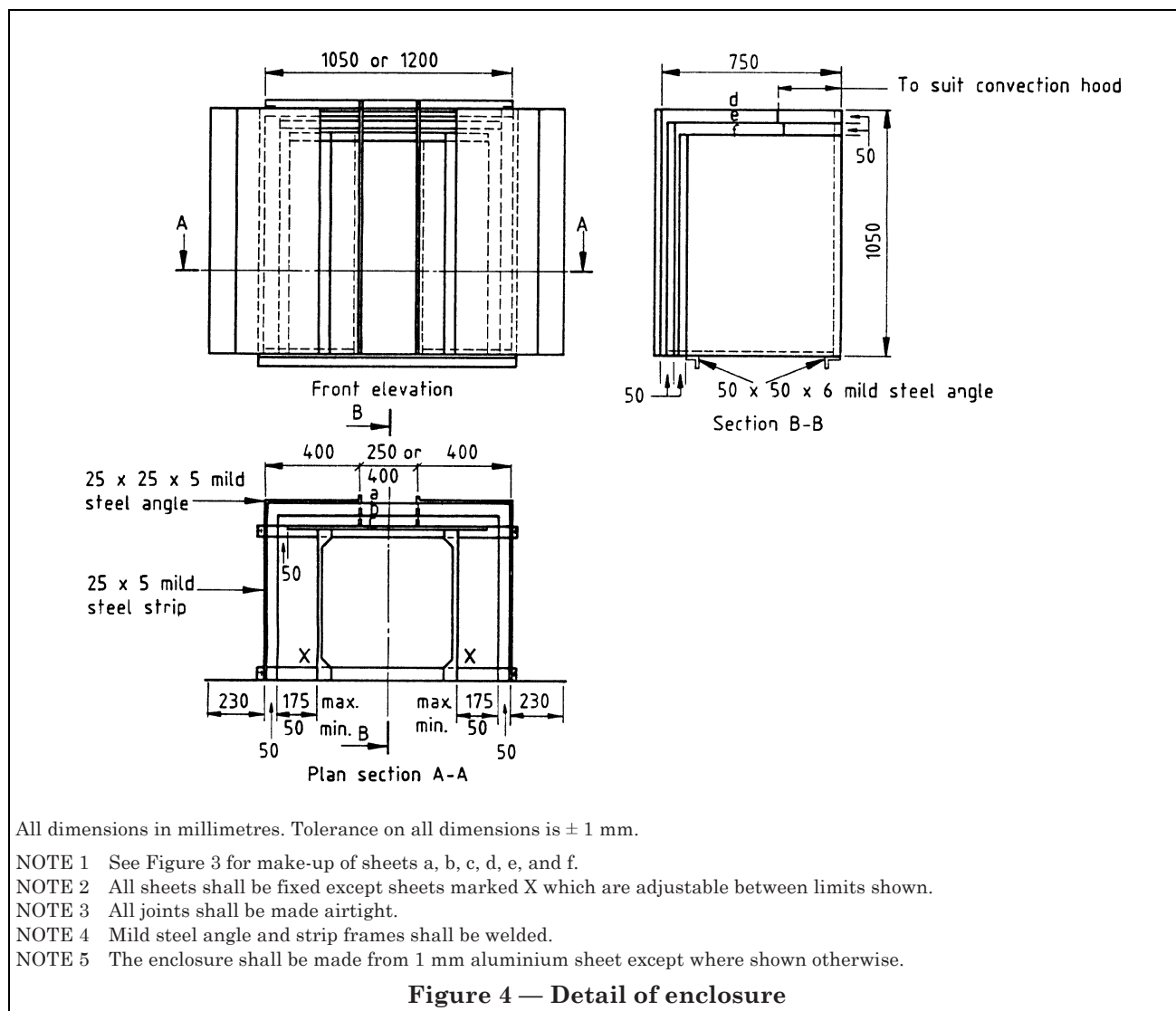
5.4 Weighing apparatus

A balance with a capacity of at least 20 kg and a minimum accuracy of ± 5 g is required for measuring the mass of fuel charged. A balance with a capacity of at least 2 kg and a minimum accuracy of ± 1 g is required for measuring the mass of ash residue.

¹⁾ For information on the availability of BCURA radiometers and calibrated radiometer elements write to Customer Services, Information, BSI, Linford Wood, Milton Keynes, MK14 6LE.

5.5 Chimney draught measurement

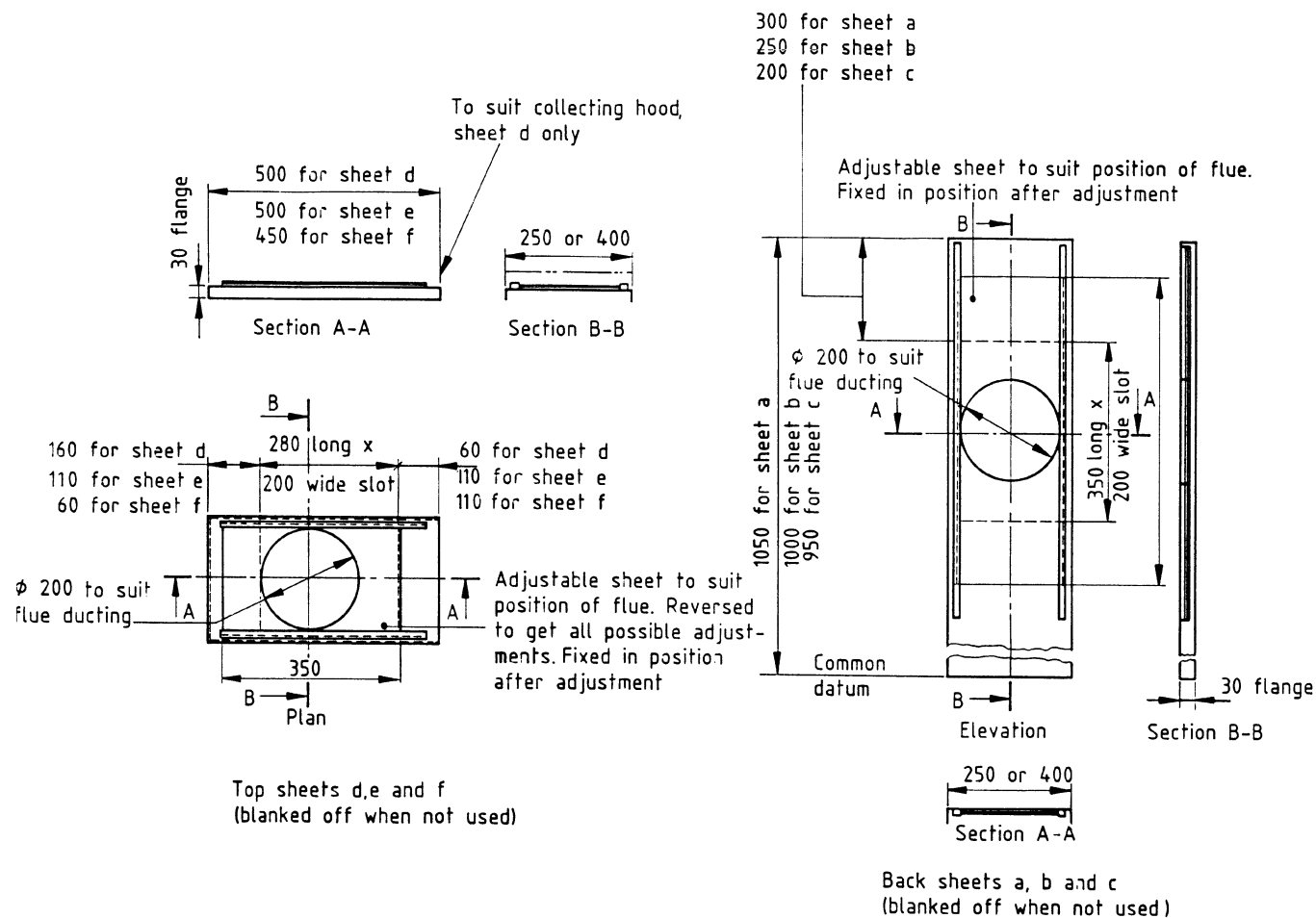
A pressure indicator or recorder with a range of at least 0 to 1 mbar and a minimum accuracy of ± 0.005 mbar is required for measurement of the chimney draught. The instrument is connected to a static pressure tapping located $1.5 \text{ m} \pm 0.1 \text{ m}$ above hearth level, either in the front face of the chimney, for inset appliances and for freestanding appliances with a rear flue outlet, or in the vertical flue pipe above the top of the test enclosure, for freestanding appliances with a top flue outlet. It is essential that the end of the tube of the pressure tapping is flush with the inner wall of the chimney flue or flue pipe.



5.6 Miscellaneous pressure measurements

The following instruments are required.

- A barometer shall be used for measuring atmospheric pressure. It shall have a range of approximately 900 mbar to 1 100 mbar and a minimum accuracy of ± 0.1 mbar.
- A micromanometer shall be used for measuring the static pressure on the up-stream side of the air flow measuring system for the flow through the collecting hood. It shall have a range of at least 0 to 10 mbar and a minimum accuracy of ± 0.05 mbar.
- Where orifice plates are used to determine the air flow through the collecting hood, a micromanometer shall be used to measure the pressure drop. It shall have a suitable range and accuracy to ensure that the air flow measurement requirements of 5.2.3 are met.



All dimensions in millimetres. Tolerance on all dimensions is ± 1 mm.

Figure 5 — Detail of flue outlet plates