BRITISH STANDARD

BS 5248:1990

Incorporating Amendment No. 1

Specification for

Aspirated hygrometer

Confirmed January 2010

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Laboratory Apparatus Standards Policy Committee (LBC/-) to Technical Committee LBC/4, upon which the following bodies were represented:

British Laboratory Ware Association
British Medical Association
Department of Health
Department of Trade and Industry (National Physical Laboratory)
Institute of Petroleum
Medical Sterile Products Association
Scientific Glassware Association

This British Standard, having been prepared under the direction of the Laboratory Apparatus Standards Policy Committee, was published under the authority of the Board of BSI and comes into effect on 31 May 1990

First published October 1975
First revision May 1990

The following BSI references relate to the work on this standard:
Committee reference LBC/4
Draft for comment 88/56009 DC

ISBN 0 580 18060 3

Amendments issued since publication

Amd. No.	Date of issue	Comments
7383	January 1993	Indicated by a sideline in the margin

Contents

Foreword

This British Standard has been prepared under the direction of the Laboratory Apparatus Standards Policy Committee and supersedes BS 5248:1975 which is withdrawn.

This British Standard was first published in 1975 as a result of a growing demand for a type of wet and dry bulb hygrometer which was more accurate than the whirling hygrometer specified in BS 2842.

The accuracy of the measurement of humidity using a whirling hygrometer is limited by the rapid rise in the wet bulb thermometer temperature when the rotation of the instrument is stopped in order to read the thermometer. Additional errors arise when the instrument is not fitted with radiation shields and the presence of the observer may also affect the humidity of the air. These sources of error are eliminated or reduced by the use of an aspirated hygrometer.

The electrically aspirated instrument is recommended to obtain the highest reproducibility of readings.

This revision introduces changes to bring the standard up to date and in particular to modify the information on available glasses and arrangements for calibration and testing.

For the information of users a method of using the aspirated hygrometer is given in Appendix A.

Tables suitable for use with aspirated hygrometers are listed in Appendix B, and Appendix C gives the maximum errors in the computed relative humidity due to thermometer errors.

Appendix D lists thermometric glasses approved by the National Physical Laboratory and Appendix E gives details of the testing of British Standard thermometers.

Product certification. Users of this British Standard are advised to consider the desirability of third party certification of product conformity with this British Standard based on testing and continuing surveillance, which may be coupled with assessment of a supplier's quality systems against the appropriate Part of BS 5750.

Enquiries as to the availability of third party certification schemes will be forwarded by BSI to the Association of Certification Bodies. If a third party certification scheme does not already exist, users should consider approaching an appropriate body from the list of Association members.

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 10, 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.

Section 1. General

1 Scope

This British Standard specifies requirements for mercury-in-glass thermometers suitable for use in an electrically or mechanically aspirated wet and dry bulb hygrometer together with the essential construction and performance requirements for the frame.

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

Section 2. Thermometers

2 Types

The thermometers shall be of the mercury-in-glass gas-filled, solid-stem or enclosed-scale types, graduated for complete immersion (graduated to give a correct reading when the whole of the thermometer is immersed in the medium the temperature of which is to be measured), and fitted with caps and collars.

NOTE Generally the thermometers fitted to the hygrometer are of the solid-stem type. However, it is desirable to use the enclosed-scale type for the measurement of low relative humidities, i.e. for large wet bulb depression of about 10 °C to 15 °C, because the heat conduction down the stem to the wet bulb is less.

3 Range

The nominal scale ranges for the thermometers shall be as follows:

0 °C to 55 °C;
– 15 °C to + 40 °C;
– 35 °C to + 20 °C.

For a 0 °C to 50 °C thermometer the scale shall be extended by two divisions below 0 °C.

NOTE The scale, if required, may also be extended by six divisions, i.e. 3 °C, above 55 °C, to accommodate its use in the environment testing of electronic components (see BS 2011-2.1Db).

4 Temperature scale

The thermometers shall be graduated in degrees Celsius, as defined in the International Temperature Scale of 1990[1)].

5 Material

The stem or capillary tube shall be of thermometric glass appropriate to the temperature range with an enamel back. The bulb shall be made of a thermometric glass approved by the National Physical Laboratory (see Appendix D).

6 Annealing

Stress in the glass shall be reduced to a level sufficient to minimize the possibility of fracture due to mechanical or thermal shock.

7 Stabilization

The thermometers shall be stabilized before graduation using a process such that the accuracy of the finished thermometer is within the limits specified in clause **10**.

8 Construction

8.1 Neck

There shall be a slight neck in the stem, at a point 14 ± 2 mm of unchanged capillary tube above the thermometer bulb, to allow a closely fitting cylindrical absorbent cotton sleeve of suitable type to be fitted securely round the bulb (see Figure 1).

8.2 Collar

A cylindrical non-ferrous metal collar and a flanged cylindrical non-ferrous metal cap shall be securely fixed with waterproof adhesive coaxially to the stem of the thermometer as shown in Figure 1.

8.3 Expansion chamber

The thermometer shall be so constructed as to withstand a temperature of 70 °C without damage. To enable the thermometer to withstand this temperature a pear-shaped expansion chamber with a hemispherical top, shall be provided towards the top of the stem. This chamber shall not be obscured by the cylindrical cap. There shall be at least 10 mm of unchanged capillary tube above the highest scale line.

8.4 Dimensions

The thermometer (whether solid-stem or enclosed-scale) shall be in accordance with Table 1 and Figure 1. Compliance with the provisions for the diameter of bulb and stem shall be tested by means of appropriate ring gauges.

Table 1 — Dimensions for thermometer

	Length	Diameter
	mm	mm
Bulb	19 ± 4	4 ± 0.5
Stem between bulb and neck	14 ± 2	$5^{+0}_{-0.5}$
Stem above neck	—	$6^{+1}_{-0.5}$
Collar	16 ± 2	9.5 ± 0.1
Body of cap	18 ± 2	9.5 ± 0.1
Flange of cap	1 ± 0.2	11 ± 0.3
Thermometer, overall	280 ± 8	—
Minimum nominal scale	145	—
From top of tap to top of collar	210 ± 2	—
Maximum from top of cap to lower limit of nominal scale	206	—

[1)] The International Temperature Scale of 1990, HMSO 1991.

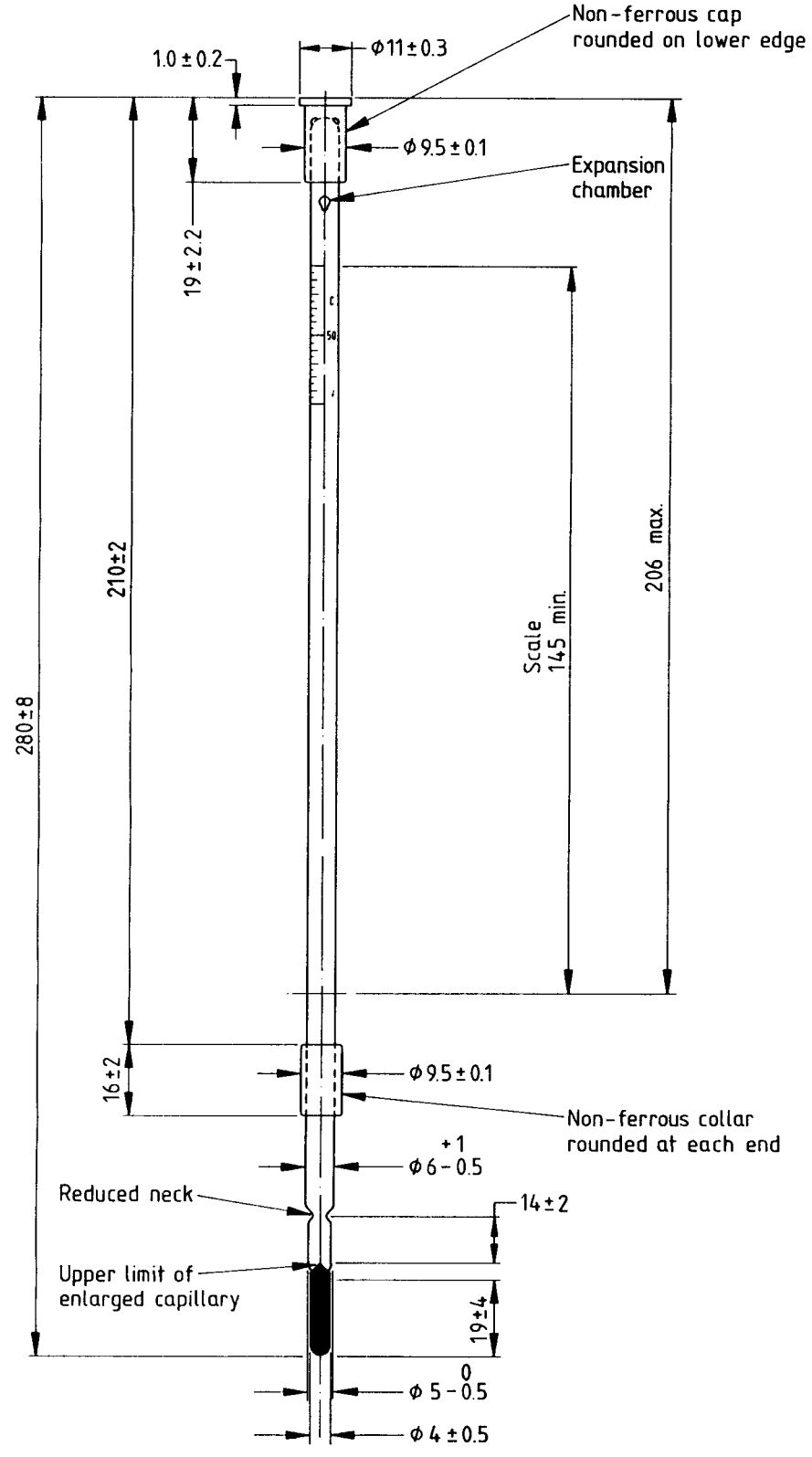

Figure 1 — Thermometer with fitted cap and collar

9 Graduation and figuring

9.1 Scale lines

The thermometer (whether solid-stem or enclosed-scale) shall be graduated at each 0.5 °C, with a longer line at each 1 °C. The lines shall be fully numbered at each 5 °C. All scale lines shall be clearly etched or otherwise durably marked, shall not exceed a thickness of 0.15 mm and shall be suitably placed in relation to the enamel back.

9.2 Figuring

The figures shall be upright when the thermometer is held vertically and viewed from the front and shall be placed so that they would be intersected by the lines to which they refer if these lines were extended. All negative figures shall have a minus sign placed above them.

9.3 Datum line

An enclosed-scale thermometer shall bear a permanently marked datum line, of thickness comparable with that of the scale lines and placed on the sheath on a level with a main scale line, so that any displacement of the scale can be easily noticed.

10 Accuracy

The accuracy of the thermometers shall be as follows.

a) *Permissible error at a point*

1) At points below 0 °C: ± 0.3 °C.

2) At 0 °C and points above: ± 0.2 °C.

b) *Permissible change in error over any interval of 10 °C*

1) For an interval below 0 °C: 0.25 °C.

2) For an interval above 0 °C: 0.1 °C.

11 Marking

Each thermometer shall be permanently and legibly marked with the following.

a) The symbol °C or an abbreviation of the name Celsius, e.g. C.

b) The identification of the bulb glass, e.g. by a coloured stripe or stripes on the bulb or an approved abbreviation on the stem (see Appendix D).

c) An identification number.

d) The maker's and/or vendor's name or readily identifiable trade mark.

e) If required, the owner's name or trade mark.

f) The number of this British Standard, i.e BS 5248[2)].

[2)] Marking BS 5248 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is therefore solely the responsibility of the person making the claim. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.

Section 3. Frame

12 General

The frame shall be of robust construction designed to accommodate two similar thermometers of a type in accordance with clause **2**, held securely side by side, and provided with means of drawing air over the bulbs at the required rate (see Figure 2).

The electric or clockwork motor and the aspirating fan assembly shall be readily removable from the frame.

13 Radiation shields

The thermometer bulbs shall be protected from external radiation by double-walled shields which form the air intake and extend at least 5 mm above the top of the bulb and at least 10 mm below the bottom of the bulb. The air shall pass between the walls of the shields as well as past the thermometer bulbs. The shields shall be non-corrodible, highly polished inside and outside and thermally insulated from each other and from the frame. The shields shall be readily removable for access to the thermometer bulbs.

14 Aspirating motor

NOTE It is intended that the references in **14.1** and **14.3** to BS 3456-101 should be replaced by reference to BS EN 61010-1, when that standard is published. BS EN 61010-1 will include safety requirements for various types of laboratory equipment.

14.1 The motor shall be suitable for operation in environmental temperatures of – 35 °C to + 57 °C. When tested with the most unfavourable voltage (as determined by the testing authority) between 0.94 and 1.06 times the rated voltage, at 50 °C for 10 min, the temperature rise of the windings and other parts of the equipment shall not exceed the values given in Table 3 of BS 3456-101:1978.

14.2 Electric motors shall create no interference in the radio and television frequency bands and shall comply with BS 800.

14.3 Electric motors and associated electrical parts shall comply with clauses **8**, **15**, **16**, **19**, **21**, **22**, **25**, **27** and **29** of BS 3456-101:1978.

14.4 Mains-operated electric motors shall be provided with a cable of a minimum length of 3 m.

15 Thermometer locating holes

The thermometer locating holes in the top mounding plate and in the portion above the radiation shields shall be coaxial. Means shall be provided to retain the thermometers in place after removal of the motor and also to prevent them from rotating during aspiration.

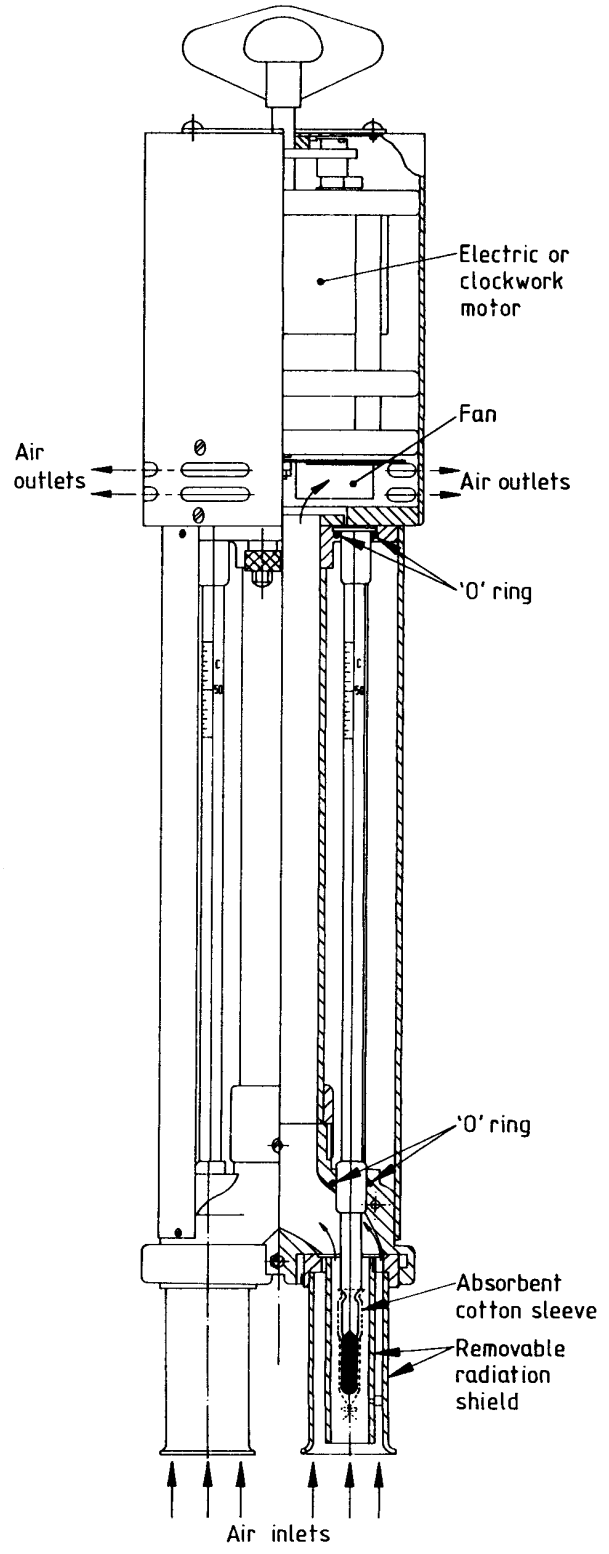

Figure 2 — General arrangement of aspirated hygrometer assembly

16 Ventilation rate

16.1 Electric motor

The speed of the air flowing past the thermometer bulbs shall be between 4.5 m/s and 9 m/s.

16.2 Clockwork motor

The speed of the air flowing past the thermometer bulbs shall be between 3 m/s and 9 m/s, maintained for at least 7 min in one full winding.

17 Carrying case and accessories

The aspirated hygrometer shall be supplied in a carrying case with compartments containing the following accessories:

a) 1 m length of sleeve;

b) a supply of cotton thread;

c) 1 water applicator;

d) 1 suspension rod;

e) 6 spare O-rings.

Provision shall be made in the carrying case for the thermometers to be housed separately from the instrument in securely held protective cases during transit.

18 Marking of carrying case and frame

A label shall be affixed to both the frame and the carrying case, bearing the following inscriptions:

a) maker's and/or vendor's name or readily identifiable trade mark;

b) owner's name or trade mark (if required);

c) identification number;

d) rated supply voltage (if applicable);

e) the number of this British Standard, i.e. BS 5248[3)].

[3)] Marking BS 5248 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is therefore solely the responsibility of the person making the claim. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.

Appendix A Method of use of aspirated hygrometer

A.1 Preliminary preparation

The sleeve should be woven from cotton in a braid form and have a width of 6 mm. Before it is fitted to the thermometer the sleeve should be made water absorbent. This can be achieved by boiling for about 10 min in water to which a little detergent has been added and then thoroughly rinsing in distilled or deionized water.

When handling the sleeve, care should be taken to prevent contamination by dirt or grease from the hands.

The sleeve should be replaced when it becomes dirty or contaminated or when readings appear suspect.

Only distilled or deionized water should be used for wetting the sleeve.

NOTE Distilled water from garages may be contaminated with acid and is not recommended.

A.2 Siting

For measurements of air temperature and humidity during outdoor meteorological observations in calm or light winds, the instrument should be suspended in an open situation with the air inlets about 1.25 m above ground level. It should be on the windward side of the support and turned so that the side of the frame shields the thermometers from direct sunshine or other radiation. If no support is available or when the wind strength is moderate or more, the instrument should be held in the hand to the windward as far away from the body as possible and tilted slightly so that the inlets face into the wind. However, care should be taken not to point the instrument in the direction of the sun, nor should it be held near any object whose temperature may differ from that of the air.

For measurements in an enclosed environment the instrument should be suspended in such a position that a truly representative sample of air is drawn through the hygrometer.

A.3 Preparation for taking a reading

Readings should only be taken when the aspirating fan is rotating at its normal speed. A clockwork motor should be rewound as necessary.

A well-fitting cylindrical cotton sleeve should be placed over one thermometer bulb so that it extends from above the slight neck to 7 mm below the bottom of the bulb and should be secured with cotton thread at the neck and immediately below the bulb. The sleeve should be moistened by immersing the wet bulb in distilled or deionized water for about 15 s, until thoroughly soaked, but a longer period may be required for a new sleeve or for the initial wetting before a series of observations. A glass tube with a rubber bulb fitted at one end or a similar device made of polyethylene provides a convenient means of water application.

If a long series of observations is being made, the wet bulb should be moistened frequently. The effect may only last about 15 min in conditions of low humidity. After each moistening a period of 1.5 min to 2 min may be required for the wet bulb temperature to stabilize, unless the water used is already at about the wet bulb temperature.

When the wet bulb temperature is below freezing point, ice-cold water should be used and, if necessary, the water should be induced to freeze on the sleeve by touching it with ice, hoar frost or a fine pointed object.

A.4 Reading

When aspiration has proceeded for about 2 min, readings of the wet bulb thermometer should be taken at 10 s intervals until the reading has ceased to fall and at least three consecutive readings are constant to within 0.1 °C. A reading should then be taken of the dry bulb thermometer. If the last three readings of the wet bulb thermometer do not agree to with 0.1 °C because of fluctuations both up and down, mean values of both wet and dry bulb temperatures taken over a period of about 1 min should be used.

A.5 Derivation of relative humidity

From the readings of the wet bulb and dry bulb thermometers, the relative humidity, dew point or vapour pressure of the water in the air can be obtained from hygrometric tables for aspirated hygrometers (see Appendix B).

Appendix B Tables suitable for use with aspirated hygrometers

The following tables are suitable for use with aspirated hygrometers:

hygrometric tables for aspirated hygrometer readings in degrees Celsius, Part III, MO 2650, HMSO 1964.

Alternative means of computing relative humidity from aspirated hygrometer readings are provided for on the Meteorological Office humidity slide rule Mk 6 (Celsius).

For further information see the following:

Measurement of Humidity (Notes on Applied Science No. 4), HMSO 1970

Handbook of Meteorological Instruments, HMSO 1956, p. 176

BS 1339, *Definitions, formulae and constants relating to the humidity of air*.

BS 4833, *Schedule for hygrometric tables for use in the testing and operation of environmental enclosures*.

Appendix C Errors in computed relative humidity due to thermometer errors

This British Standard specifies that the thermometers shall not be in error by more than the values given in clause **10**. The maximum error in the wet bulb depression is therefore 0.6 °C when both temperatures are below 0 °C, 0.4 °C when both temperatures are at or above 0 °C, and 0.5 °C when the dry bulb is at or above 0 °C and the wet bulb is below 0 °C.

A higher accuracy may be achieved if the two thermometers, each being within the limits of accuracy specified in clause **10**, are also matched to within 0.2 °C. This requirement has not been included in the specification as the thermometers may often be replaced individually, but it might reasonably be specified in a contract for the supply of new hygrometers. The maximum errors in the computed relative humidity which then correspond to a maximum error in the wet bulb depression of 0.2 °C are shown in Table 2.

When the thermometer has been tested and certified by an approved laboratory and if the appropriate corrections are applied to the readings, the maximum error in the wet bulb depression should not exceed 0.1 °C and the corresponding maximum errors in the computed relative humidity are shown in Table 2.

Table 2 — Maximum error in computed relative humidity due to thermometer error

Thermometers	Temperature of dry bulb (°C)					
	– 10	– 5	0	10	20	30
	Relative humidity					
	%	%	%	%	%	%
Using unmatched thermometers: maximum error as in clause **10**	18	14	10	5	4	3
Using matched thermometers: matched to 0.2 °C	6	5	4	2	2	1
Using thermometers NAMAS calibrated to ± 0.05 °C	3	2	2	1	1	1
If misread by up to 0.1 °C then add a further:	6	5	4	2	2	1

NOTE For dry bulb at or above 0 °C and wet bulb below 0 °C, the maximum error in the wet bulb depression is 0.5 °C. The value given in this table for dry bulb at 0 °C is conservatively based on a maximum temperature error of 0.6 °C.

Appendix D Thermometric glasses approved by the National Physical Laboratory

Table 3 gives the identification stripes or approved abbreviations of all glasses that have been approved for the manufacture of thermometer bulbs. Only Jenaer Glaswerk Schott and Genossen continue to supply glasses.

A comprehensive list is retained, however, to assist users of existing or old thermometers in the certification of both the bulb glass and the recommended working temperature ranges.

Table 3 — Identification stripe(s) or approved abbreviations and normal maximum working temperature of all glasses that have been approved for the manufacture of thermometer bulbs

Glass	Supplier	Identification stripe(s) or approved abbreviation	Normal maximum working temperature
			°C
Normal glass Schott-N16	Jenaer Glaswerk Schott and Genossen Mainz	Single red stripe or N16	350
Thermometric glass Schott-2954	Jenaer Glaswerk Schott and Genossen Mainz	Single black stripe	460
Schott-Supremax R 8409	Jenaer Glaswerk Schott and Genossen Mainz	SPX 8409	600
Normal glass	Whitefriars Glass Ltd.	Single blue stripe	350
Normal glass, dial	Plowden and Thompson Ltd.	Double blue stripe	350
Normal glass 7560	Corning Glass Co.	CN	350
Corning borosilicate glass	Corning Glass Co.	CB	450
Borosilicate glass	Whitefriars Glass Ltd.	Single white stripe	460

NOTE The maximum temperatures given in the last column of the table are a guide to normal practice. The performance of a thermometer depends greatly on the stabilizing heat treatment which it has been given during manufacture, and a well-made thermometer of "normal glass" may be quite satisfactory for many purposes at temperatures as high as 400 °C. On the other hand, for the best accuracy it may be preferred to use one of the borosilicate glasses for temperatures lower than 350 °C. In general, the lower the maximum temperature of use in relation to the approved temperature of the glass, the better will be the "stability of zero" of the thermometer.

Appendix E Testing of thermometers

The examination and calibration of thermometers is undertaken by the National Physical Laboratory and by approved laboratories of the National Measurement Accreditation Service (NAMAS). Full details of services and fees can be obtained on application to individual laboratories. A list of NAMAS approved laboratories can be obtained from NAMAS, National Physical Laboratory, Teddington, Middlesex TW11 0LW (telephone 01 977 3222).

It is desirable that thermometers be retested at intervals not exceeding five years, or more frequently if determinations at a reference point indicate that retest is required. A change of one or two divisions does not necessarily indicate the need for a complete retest, as this may be due to a normal change in the volume of the bulb and may be allowed for by applying a correction, equal to the zero change, throughout the scale.

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Publications referred to

BS 800, *Specification for radio-interference limits and measurements for household appliances, portable tools and other electrical equipment causing similar types of interference.*

BS 2011, *Basic environmental testing procedures.*

BS 2011-2.1 Db, *Test Db and guidance: Damp heat, cyclic (12 + 12 hour cycle).*

BS 2842, *Specification for whirling hygrometer*[4)].

BS 3456, *Specification for safety of household appliances and similar electrical appliances.*

BS 3456-101, *General requirements.*

BS 5750, *Quality systems*[4)].

The International Temperature Scale of 1990, HMSO 1991.

See also Appendix B.

[4)] Referred to in the foreword only.

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