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Specification for

Short-range short-stem thermometers

Committees responsible for this British Standard

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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

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Contents

		Page
Committees responsible		Inside front cover
Foreword		ii
1	Scope	1
2	Type and designation	1
3	Temperature scale	1
4	Bulb	1
5	Stem	1
6	Annealing	1
7	Stabilization	1
8	Graduation and figuring	1
9	Immersion line	1
10	Expansion volume	4
11	Finish	4
12	Enlargements of the bore	4
13	Dimensions of scale ranges	4
14	Marking	4
Appendix A Emergent liquid column temperatures for partial immersion thermometers		5
Appendix B Testing of thermometers		5
Appendix C Thermometric glasses approved by the National Physical Laboratory		5
Appendix D Stabilization test		6
Figure 1 — Examples of scale lines and figuring		2
Table 1 — Graduation, figuring and general dimensions		2
Table 2 — Scale ranges and tolerances		3
Table 3 — Recommended limits of uncertainty of test		6
Table 4 — Identification stripe(s) or approved abbreviations and normal maximum working temperature of all glasses that have been approved for the manufacture of thermometer bulbs		7
Publication referred to		Inside back cover

Foreword

This British Standard has been prepared under the direction of the Laboratory Apparatus Standards Policy Committee, and supersedes BS 1365:1975 which is withdrawn.

This British Standard was first published in 1951 to meet the requirements for thermometers of the Anschutz and similar types, i.e. with comparatively short stems and graduated to cover scale spans of approximately 60 °C (series A) and 10 °C (series B).

The first revision in 1975 introduced a more open scale for both series A and B thermometers to facilitate reading without loss of accuracy and a greater permissible error for series A thermometers. An appendix on emergent liquid column temperature correction (Appendix A) was added for use with thermometers under partial immersion conditions.

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 but retains the other requirements of the 1975 edition.

Series A refers to a series of overlapping short-range thermometers which collectively cover a range of – 10 °C to + 360 °C.

Series B refers to a series of overlapping short-stem thermometers which collectively cover a range of – 10 °C to + 220 °C.

Series B thermometers are recommended for use in determining melting points and setting points.

Information on the testing of short-range short-stem thermometers is given in Appendix B.

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.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 8, 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 specifies requirements for two series, A and B, of mercury-in-glass thermometers. In each series, thermometers calibrated for total immersion, i.e. immersion to the reading (designated A1 or B1) and thermometers calibrated for partial immersion (designated A2 or B2) are included for each temperature range.

Series A1 comprises seven total immersion thermometers, each with a scale span of approximately 60 Celsius degrees, covering the range – 10 °C to + 360 °C.

Series A2 covers the same range for an immersion of 80 mm.

Series B1 comprises 24 total immersion thermometers, each with a scale span of approximately 10 Celsius degrees, covering the range – 10 °C to + 220 °C.

Series B2 covers the same range for an immersion of 70 mm.

NOTE The title of the publication referred to in this standard is listed on the inside back cover.

2 Type and designation

Thermometers shall be of the mercury-in-glass solid-stem type and shall be filled with inert gas at an appropriate pressure. Each thermometer shall be designated by a designation consisting of the code letters SA or SB (for short-range series A or B respectively), followed by a nominal maximum working temperature and an indication of the immersion depth at which the thermometer is to be used, e.g. SA 55C/Total, SB IC/70.

3 Temperature scale

Thermometers shall be graduated in accordance with the Celsius scale as defined in the current definition of the International Practical Temperature Scale adopted by the General Conference of Weights and Measures (CGPM).

4 Bulb

The bulb shall be cylindrical and in alignment with the stem. Its external diameter shall not exceed that of the stem. It shall be of a thermometric glass approved by the National Physical Laboratory and suitable for the range of temperature covered (see Appendix C).

5 Stem

For thermometers in which the upper level of the scale is above 300 °C, the same thermometric glass shall be used for both the bulb and the stem.

NOTE For thermometers in which the upper level of the scale is 300 °C or less, it is recommended that the stem should be made of the same thermometric glass as the bulb but it is also permissible for the stem to be made of lead glass or other suitable glass with an enamel back.

6 Annealing

Strain 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 thermometer shall be stabilized before graduation using a process such that, when tested in accordance with Appendix D, the maximum error and maximum change in error over any interval of the finished thermometer is within the limits specified in Table 2 and the rise at the selected reference point is not greater than the maximum error allowed.

8 Graduation and figuring

The scale lines shall be clearly etched or otherwise durably marked, and of uniform thickness. The lines shall lie in planes at right angles to the axis of the thermometer. When the thermometer is held in a vertical position, and viewed from the front, the left-hand ends of all the scale lines shall lie on an imaginary vertical line.

NOTE When the thermometer is held in a vertical position and viewed from the front, the figures may be either horizontal or vertical, provided all are clearly visible.

The figures shall be placed so that they would be intersected by the line to which they refer if the lines were extended.

When the thermometer is viewed such that the right-hand ends of the shortest lines denoting the smallest interval are aligned with the left-hand side of the bore (see Figure 1), then the medium and long lines shall extend across the bore towards the right.

The lengths of the scale lines shall be in accordance with Table 1.

9 Immersion line

In partial immersion thermometers, a line shall be permanently marked on the stem at the point to which the thermometer is intended to be immersed. If the immersion point is below the lowest scale line, the immersion line shall be a ring carried completely round the stem. If the immersion point is above the lowest scale line, the immersion line shall be confined to the back of the stem.

The depth of immersion shall be within ± 1 mm of the value specified in the appropriate table and shall be measured from the bottom of the bulb.

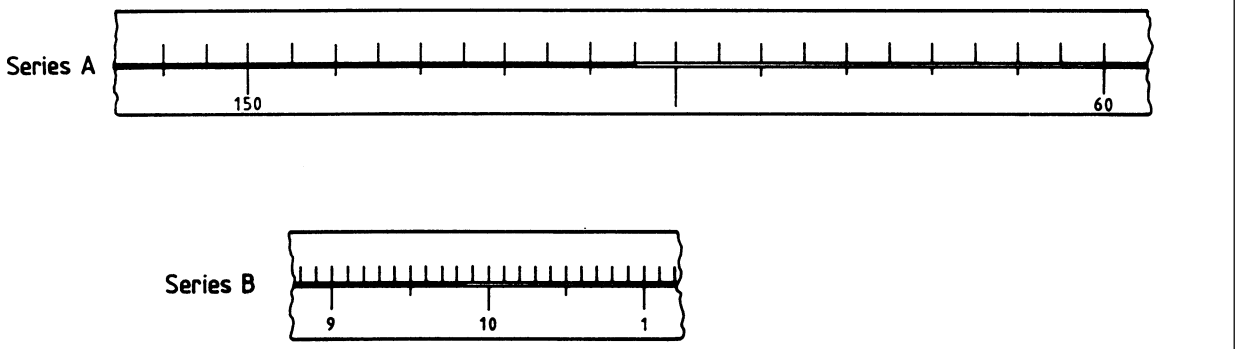

Figure 1 — Examples of scale lines and figuring

Table 1 — Graduation, figuring and general dimensions

	Series A thermometers	Series B thermometers
Scale lines	Short lines at each 0.5 °C; medium lines at each 1 °C; long lines at each 5°c	Short lines at each 0.1 °C; medium lines at each 0.5 °C; long lines at each 1 °C
Figuring	Fully figured at each 50 °C; partially figured at each 10 °C	Fully figured at each 5 °C; partially figured at each 1 °C
Maximum thickness of scale lines	0.1 mm	0.1 mm
Maximum overall length	220 mm	240 mm
Minimum length of main scale	100 mm	80 mm
Maximum bulb length	12 mm	35 mm
Stem diameter	5.5 mm to 8 mm	5.5 mm to 8 mm
Bulb diameter	Not to exceed stem diameter	Not to exceed stem diameter
Minimum distance from bottom of bulb to first division on scale	45 mm	70 mm
Maximum distance from bottom of bulb to top of contraction chamber, where provided	30 mm	55 mm

Table 2 — Scale ranges and tolerances

Series A		A1, total immersion		A2, 80 mm immersion		Average temperature of emergent liquid column (see Appendix A)
Designation	Scale range	Maximum error	Maximum error over any interval[a] at 10 °C	Maximum error	Maximum error over any interval[a] at 10 °C	
	°C	°C	°C	°C	°C	°C
SA 55C/	– 10 to + 55	0.5	0.5	1.0	1.0	20
SA 105C/	45 to 105	0.5	0.5	1.0	1.0	30
SA 155C/	95 to 155	0.5	0.5	1.0	1.0	40
SA 205C/	145 to 205	0.5	1.0	1.0	1.5	40
SA 255C/	195 to 255	1.0	1.0	2.0	2.0	50
SA 305C/	245 to 305	1.0	1.0	2.0	2.0	60
SA 360C/	295 to 360	1.0	1.0	2.0	2.0	65
Series B		**B1, total immersion**		**B2, 70 mm immersion**		**Average temperature of emergent liquid column** (see Appendix A)
Designation	**Scale range**	**Maximum error**	**Maximum error over any interval[a] at 10 °C**	**Maximum error**	**Maximum error over any interval[a] at 10 °C**	
	°C	°C	°C	°C	°C	°C
SB 1C/	– 10 to + 1111	0.2	0.1	0.2	0.2	10
SB 5C/	– 5 to + 5	0.2	0.1	0.2	0.2	10
SB 15C/	5 to 15	0.2	0.1	0.2	0.2	15
SB 25C/	15 to 25	0.2	0.1	0.2	0.2	20
SB 35C/	25 to 35	0.2	0.1	0.2	0.2	20
SB 45C/	35 to 45	0.2	0.1	0.4	0.2	25
SB 55C/	45 to 55	0.2	0.1	0.4	0.2	25
SB 65C/	55 to 65	0.2	0.1	0.4	0.2	30
SB 75C/	65 to 75	0.2	0.1	0.4	0.2	30
SB 85C/	75 to 85	0.2	0.1	0.4	0.2	30
SB 95C/	85 to 95	0.2	0.1	0.4	0.2	30
SB 105C/	95 to 105	0.2	0.2	0.4	0.4	30
SB 115C/	105 to 115	0.2	0.2	0.4	0.4	30
SB 125C/	115 to 125	0.2	0.2	0.4	0.4	30
SB 135C/	125 to 135	0.2	0.2	0.4	0.4	35
SB 145C/	135 to 145	0.2	0.2	0.4	0.4	40
SB 155C/	145 to 155	0.3	0.3	0.6	0.6	40
SB 165C/	155 to 165	0.3	0.3	0.6	0.6	40
SB 175C/	165 to 175	0.3	0.3	0.6	0.6	45
SB 185C/	175 to 185	0.3	0.3	0.6	0.6	45
SB 195C/	185 to 195	0.3	0.3	0.6	0.6	45
SB 205C/	195 to 205	0.3	0.5	1.0	1.0	50
SB 215C/	205 to 215	0.6	0.6	1.2	1.2	50
SB 220C/	210 to 220	0.6	0.6	1.2	1.2	50

[a] The algebraic difference between the errors at opposite ends of any interval of 2 °C.

NOTE Recommended values for the average temperature of the emergent liquid column during calibration are given in Table 2 (see also Appendix A).

10 Expansion volume

To minimize the effects of accidental overheating, a safety volume shall be provided at the top of the stem. If this volume takes the form of an expansion chamber, it shall be pear-shaped with the hemisphere at the top and there shall be at least 10 mm of unchanged capillary tube above the highest scale line.

NOTE 1 The expansion volume may alternatively consist of at least 30 mm of unchanged capillary tube above the highest scale line.

NOTE 2 A thermometer should not be heated above its maximum working temperature. Overheating is liable to change the indication of the thermometer, and a redetermination of a reference point may be necessary.

11 Finish

The top of the thermometer stem shall be finished plain, or with a ring or button, the external diameter of which shall not exceed that of the stem.

12 Enlargements of the bore

The shapes of the bulb, the expansion chamber and, where provided, the contraction chamber shall be such that they do not entrap mercury or gas. The contraction chamber shall be elongated and regular in form, so that the mercury column does not recede into the main bulb at 0 °C.

No scale line shall be within 10 mm of any enlargement of the bore.

13 Dimensions and scale ranges

The general dimensions for series A and B thermometers shall be in accordance with Table 1. The scale ranges and the tolerances for maximum error and for minimum error in an interval shall be in accordance with Table 2.

14 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 inscription Total immersion, 80 mm immersion or 70 mm immersion (or suitable abbreviation) to indicate the depth of immersion for which the thermometer is graduated.

c) 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 C).

d) An inscription to indicate the gas filling employed, e.g. Nitrogen filled (or suitable abbreviation).

e) An identification number.

f) The maker's and/or vendor's name or readily identifiable trademark.

g) The designation allocated to the thermometer (see clause **2**).

h) The number of this British Standard, i.e. BS 1365[1)].

[1)] Marking BS 1365 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 Emergent liquid column temperatures for partial immersion thermometers

When the average temperature of the emergent liquid column in use differs from that prevailing during calibration, appropriate corrections are required, and it is therefore important that the conditions of calibration should be known. The values given in the tables for partial immersion thermometers of series A and B are those suggested by the National Physical Laboratory.

The emergent liquid column temperature may be estimated, preferably by a faden (or thread) thermometer of suitable bulb length placed alongside the emergent column or alternatively by taking the mean of the readings of a series of auxiliary thermometers placed with the bottom of the bulb of the first of these thermometers at a distance of 10 mm from the point of emergence and the others evenly spaced along the length of the exposed column at intervals not exceeding 100 mm.

Up to a bulb temperature of about 100 °C, the two methods give results that are in agreement for most practical purposes but above this temperature the faden thermometer method is recommended as giving the more reliable and reproducible results. Where possible, the same method for estimating the emergent liquid column temperature should be adopted for the thermometer in use as when it was calibrated.

The effect on the thermometer reading caused by differences in emergent liquid column temperatures of two conditions of use may be obtained by evaluating the expression

$$KN\,(t - T)$$

where

K is the differential expansion of the liquid in the particular type of glass used.

NOTE A typical value of $1.6 \times 10^{-4}\ (°C)^{-1}$ may be assumed for mercury-in-glass Celsius thermometers.

N is the length of the exposed liquid column, as measured by comparison with the engraved scale of the thermometer, in °C.

t is the emergent liquid column temperature under the first condition, in °C.

T is the emergent liquid column temperature under the second condition, in °C.

Since there are many possible differing combinations of conditions of use, the following is given as a typical example of the application of the above expression.

An SA 305C/80 thermometer has been proved to read correctly at 300 °C for its specified emergent liquid column temperature of 60 °C.

Suppose it is used at 300 °C with an emergent liquid column temperature of 48 °C. It is observed that the length of the mercury column from the immersion line to the 300 °C reading is equivalent to 58 Celsius degrees.

Since the thermometer was proved correct with an emergent liquid column temperature of 60 °C and is used at 48 °C, the thermometer will read low by an amount $1.6 \times 10^{-4} \times 58 \times (60 - 48) = 0.11$ °C, i.e. a correction of + 0.11 °C should be added to the thermometer reading to obtain the true temperature.

A convenient chart giving emergent liquid column temperature corrections for values of $(t - T)$ from 0.1 °C to 500 °C has been prepared by the National Physical Laboratory and is published by HMSO.

Appendix B Testing of thermometers

The examination and calibration of thermometers is under-taken 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.

Table 3 gives the recommended limits of uncertainty of test for series A and B thermometers.

Appendix C Thermometric glasses approved by the National Physical Laboratory

Table 4 gives the identification stripe(s) or approved abbreviation(s) 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.

Appendix D Stabilization test

This test is appropriate to thermometers having a maximum temperature above 100 °C.

Heat the thermometer to a temperature equal to its highest graduation mark and keep it at this temperature for 5 min. Allow the thermometer to cool either naturally in still air or slowly in a controlled temperature (at a reproducible rate) to 20 °C above ambient temperature or to 50 °C, whichever is the lower, and then determine the error at a selected reference point. If natural cooling in air is used, the correction should be determined within 1 h. Heat the thermometer again to a temperature equal to its highest graduation mark, keep it at this temperature for 24 h, allow the thermometer to cool to 20 °C above ambient temperature or to 50 °C, whichever is the lower, at the same rate as in the first part of the test, and redetermine the error under the same conditions as before.

The most commonly used reference point is 0 °C, but the lowest indicated temperature on the main scale may be selected.

Table 3 — Recommended limits of uncertainty of test

Designation	Uncertainty of test	
Series A	**A1, total immersion**	**A2, 80 mm immersion**
	°C	°C
SA 55C/	± 0.05	± 0.1
SA 105C/	± 0.05	± 0.1
SA 155C/	± 0.1	
SA 205C/	± 0.1	
SA 255C/	± 0.2	± 0.2
SA 305C/		± 0.2
SA 360C/		± 0.5
Series B	**B1, total immersion**	**B2, 70 mm immersion**
	0 °C	0 °C
SB 1C/	± 0.02	± 0.05
SB 5C/		
SB 15C/		
SB 25C/		
SB 35C/		
SB 45C/		
SB 55C/		
SB 65C/		
SB 75C/		
SB 85C/		
SB 95C/		
SB 105C/	± 0.05	± 0.1
SB 115C/		
SB 125C/		
SB 135C/		
SB 145C/		
SB 155C/		
SB 165C/		
SB 175C/		
SB 185C/		
SB 195C/		
SB 205C/	± 0.1	± 0.2
SB 215C/		
SB 220C/		

Table 4 — 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 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.

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Publication referred to

BS 5750, *Quality systems*[2)].

[2)] Referred to in the foreword only.

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