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Specification for

Solid-stem calorimeter thermometers

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 30 April 1990

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Foreword

This British Standard has been prepared under the direction of the Laboratory Apparatus Standards Policy Committee and supersedes BS 791:1975 which is withdrawn.

This British Standard was first published in 1938 under the title “*Bomb calorimeter thermometers*” and revised in 1959 and 1975. BS 791:1959 was adopted as the basis of ISO recommendation 651 “*Solid stem calorimeter thermometers*” published in 1968. ISO/R 651 was confirmed as ISO 651 in 1975. The 1975 edition of BS 791 was technically in agreement with ISO 651 and also included some additional information.

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

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 4, 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 a series of short-range solid-stem thermometers for use in bomb calorimetry and for other purposes where an accurate measurement of a change of temperature is required. The thermometers are not provided with auxiliary scales at 0 °C and are therefore not suited to the absolute measurement of temperature (which is not normally required in calorimetry) unless they are checked against a standard thermometer immediately before use.

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

2 Type

The thermometer shall be of the mercury-in-glass solid-stem type with an enamel back.

3 Temperature scale

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

4 Immersion

The thermometer shall be calibrated for use at total immersion, i.e. the reading is taken when the thermometer is vertical and immersed at least to the end of the liquid column in the medium, the temperature of which is required to be measured, or for use at partial immersion.

NOTE The purchaser should specify in the enquiry or order whether a partial immersion thermometer is required.

On partial immersion thermometers, a line shall be etched at least halfway round the stem of the thermometer at the level to which it is intended to be immersed.

5 Glass

5.1 The stem shall be made of lead glass or other thermometric glass appropriate to the temperature range and shall have an enamel back.

5.2 The bulb shall be cylindrical and in alignment with the stem. Its external diameter shall not exceed that of the stem. It shall be made of a thermometric glass approved by the National Physical Laboratory (see Appendix A).

5.3 The glass shall be so selected and processed that the finished thermometer shows the following characteristics.

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

- b) The thermometer shall be stabilized before graduation using a process such that the scale error and interval error of the finished thermometer are within the limits specified in clause 9.

- c) The legibility of the reading shall not be impaired by devitrification or clouding.

- d) The image of the meniscus shall be distorted as little as possible by defects or impurities in the glass.

6 Gas filling

Above the mercury, the thermometer shall be either vacuum or gas-filled; in the latter case, only a dry, inert gas shall be used. The indication of a gas-filled thermometer, when the meniscus is at the top of the scale, shall not change by more than 0.01 °C when the temperature of the gas above the mercury is changed by 30 °C.

NOTE It is generally possible for this requirement to be satisfied if the internal gas pressure does not exceed 50 kPa when the thermometer is registering its maximum temperature.

7 Construction

7.1 Shape

The thermometer shall be straight and its external cross section shall be approximately circular.

7.2 Top finish

The top of the thermometer shall have a rounded finish, unless otherwise specially, required.

7.3 Capillary tube

The cross-sectional area of the bore shall not show variations from the average greater than $\pm 5\%$, and the shape of the bore shall be such that, without tapping, jumping of the meniscus does not exceed one half of the graduation interval, when the temperature is rising at a uniform rate not exceeding 0.05 °C/min. In the case of a thermometer calibrated for use at partial immersion, the volume of mercury contained in the capillary tube between the immersion line and the lowest figured scale line shall not exceed the equivalent of 2 °C.

NOTE The inside of the capillary tube should be smooth.

7.4 Expansion chamber (safety chamber)

The thermometer shall be so constructed as to withstand a temperature of 60 °C (or 70 °C in the case of thermometers STCa/0.01/42 and STCa/0.01/45) without damage. To enable the thermometer to withstand these temperatures, an expansion chamber, which shall be pear-shaped with a hemispherical top, shall be provided at the top of the stem. It shall be so shaped that the meniscus remains in the lower portion at temperatures up to 40 °C.

7.5 Contraction chamber

A contraction chamber shall be provided so that the mercury does not recede into the bulb at 0 °C. It shall be elongated and as narrow as possible and shall be separated from the bulb by not less than 3 mm of capillary tube of uniform bore.

7.6 Enlargement of the bore

No enlargement of the bore shall be so located as to produce any variation in the cross section of the capillary tube in the scale portion other than that specified in 7.3.

7.7 Dimensions

The thermometers shall comply with the dimensions given in Table 1 and Figure 1.

Table 1 — Dimensions (see Figure 1)

	mm
Maximum total length	760
Maximum distance from bottom of bulb to top of contraction chamber	110
Distance from bottom of bulb to lower nominal limit of scale	280 to 300
Minimum length of main scale between nominal limits	300
Minimum distance from upper nominal limit of scale to top of thermometer	70
Maximum diameter of stem	11
External diameter of bulb	not greater than that of stem
Minimum length of bulb to shoulder	40

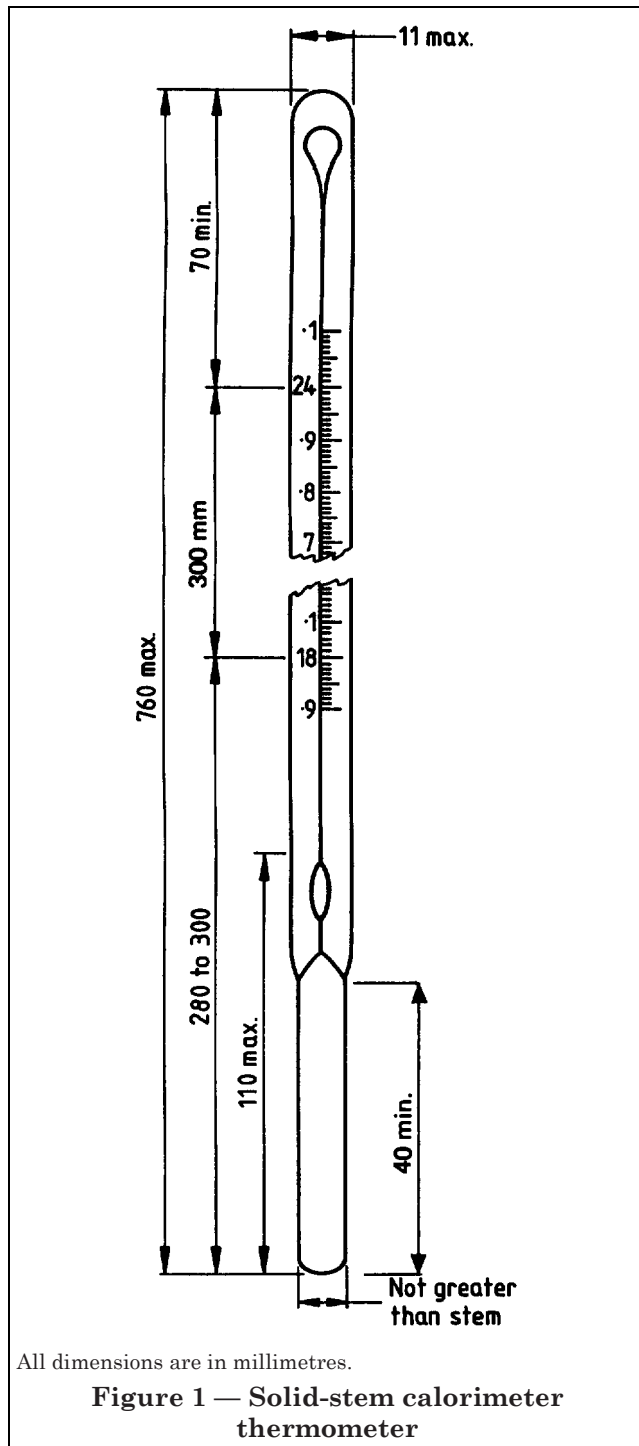
8 Graduation and figuring

8.1 The scales and graduation interval of the thermometers shall be in accordance with Table 2.

8.2 The scale lines shall be clearly etched and of uniform thickness, which in no case shall exceed 0.05 mm. The lines shall be at right angles to the axis of the thermometer.

Table 2 — Graduation

Designation	Graduation interval	Nominal scale range
	°C	°C
STCa/0.01/15	0.01	9 to 15
STCa/0.01/18	0.01	12 to 18
STCa/0.01/21	0.01	15 to 21
STCa/0.01/24	0.01	18 to 24
STCa/0.01/27	0.01	21 to 27
STCa/0.01/30	0.01	24 to 30
STCa/0.01/33	0.01	27 to 33
STCa/0.01/36	0.01	30 to 36
STCa/0.01/39	0.01	33 to 39
STCa/0.01/42	0.01	36 to 42
STCa/0.01/45	0.01	39 to 45



8.3 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. When the thermometer is viewed such that the right-hand ends of the shorter lines denoting, an interval of 0.01 °C, align with the left-hand side of the bore, longer lines at each 0.05 °C shall extend across the bore towards the right.

NOTE The shorter lines should be about 1 mm long.

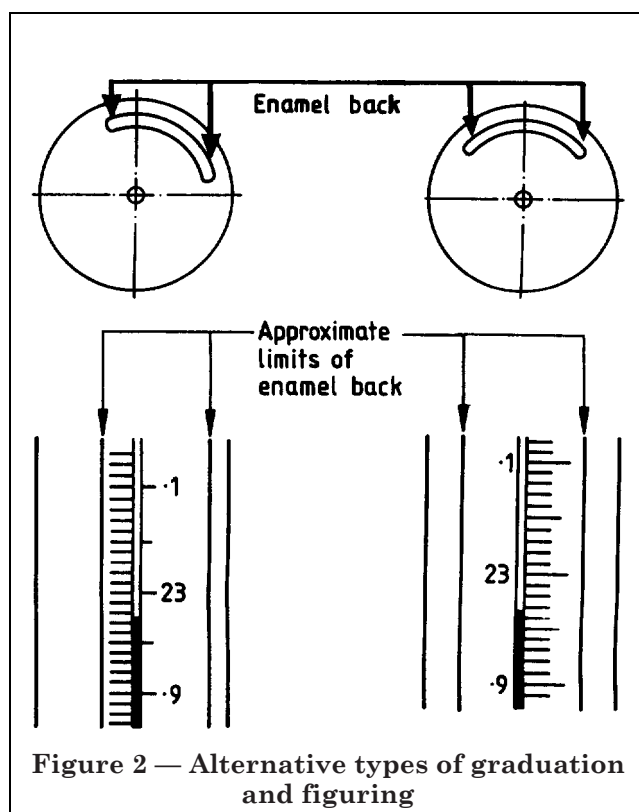
8.4 The figures shall be placed in such a way that an extension of the line to which they refer would intersect them. The figures shall be upright when the thermometer is held vertically (see Figure 2).

NOTE 1 The figures may be placed either to the right or the left of the scale lines, as preferred.

NOTE 2 Figure 2 illustrates two different types of graduation and figuring for the thermometers, but these are not intended to be obligatory.

8.5 The scale lines shall be so positioned that the enamel backing in the stem provides a background for the figures, the scale and the mercury column when the latter is seen just beyond the left-hand or right-hand ends of the short lines.

8.6 The scale of the thermometer shall be extended at each end by 10 divisions, i.e. $0.1\text{ }^{\circ}\text{C}$, beyond the nominal limits specified in Table 2.



8.7 The scale shall be figured at each division of $0.1\text{ }^{\circ}\text{C}$. Full figuring shall be provided at least at each division of $1\text{ }^{\circ}\text{C}$ and more frequently if required.

9 Accuracy (see Appendix B)

9.1 Scale error

The scale error, when the thermometer is under standard atmospheric pressure and when the emergent liquid column (in the case of a partial immersion thermometer) is at the prescribed temperature, shall not be greater than $0.1\text{ }^{\circ}\text{C}$.

9.2 Interval error

The absolute value of the algebraic difference between the errors at any two points on the scale which are not more than 50 divisions apart shall in no case be greater than $0.01\text{ }^{\circ}\text{C}$.

9.3 Repeatability

The repeatability of readings on the thermometer shall be such that the correction at any point on the scale can be determined with an accuracy of $\pm 0.002\text{ }^{\circ}\text{C}$.

10 Marking

The following inscriptions shall be permanently and legibly marked on the thermometer.

- Unit of temperature, i.e. abbreviation of the name Celsius such as C or the symbol $^{\circ}\text{C}$.
- On each thermometer graduated for use at partial immersion, the immersion depth and the emergent stem temperature for which the thermometer was calibrated.
- Bulb glass identification, preferably by means of a coloured stripe or stripes, or by an approved abbreviation inscribed on the stem (see Appendix A).
- Gas filling identification, if any, e.g. nitrogen filled, vacuum or a suitable abbreviation.
- Identification number (manufacturer's).
- Maker's and/or vendor's name or readily identifiable trade mark.
- Designation allotted to the thermometer, e.g. "STCa/0.01/15" (see Table 2).
- The number of this British Standard, i.e. BS 791.

Appendix A Thermometric glasses approved by the National Physical Laboratory

Table 3 gives the identification stripe(s) 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
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 B 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).

Publications referred to

BS 5750, *Quality systems*¹⁾.

ISO 651, *Solid stem calorimeter thermometers*¹⁾.

¹⁾ Referred to in the foreword only.

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