BRITISH STANDARD

BS 1704:1985
ISO 1770:1981
Incorporating Amendment No. 1

Specification for

Solid-stem general purpose thermometers

UDC 536.512/.513

Committees responsible for this British Standard

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

British Laboratory Ware Association
British Lampblown Scientific Glassware Manufacturers' Association Ltd.
British Medical Association
Department of Health and Social Security
Department of Trade and Industry (National Physical Laboratory)
Institute of Petroleum
Ministry of Defence

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Contents

National foreword

This British Standard has been prepared under the direction of the Laboratory Apparatus Standards Committee. This edition is identical with ISO 1770:1981 "*Solid-stem general purpose thermometers*" published by the International Organization for Standardization (ISO) and incorporates a change to clause **11** brought about by Amendment 1 to ISO 1770 issued in August 1983. This standard supersedes BS 1704:1951 which is withdrawn.

The principal differences between the 1951 edition and this edition include the introduction of a series of greater accuracy intended for possible testing by a national verification laboratory, the withdrawal of thermometers marked in Fahrenheit, and changes to the scale division, accuracy and line thickness.

National appendix A gives details of testing of the thermometers J to W.

Terminology and conventions. The text of the International Standard has been approved as suitable for publication as a British Standard without deviation.

Some terminology and certain conventions are not identical with those used in British Standards; attention is drawn especially to the following.

The comma has been used as a decimal marker. In British Standards it is current practice to use a full point on the baseline as the decimal marker.

Wherever the words "International Standard" appear, referring to this standard, they should be read as "British Standard".

Cross-reference. The reference to ISO 386, which only appears in clause **0**, is of an informative nature only and the lack at present of an equivalent British Standard therefore does not affect the validity of this standard.

Additional information. Attention is drawn to the requirement for marking in clause **11**[1)].

Certification. Attention is drawn to the certification facilities described on the inside back cover.

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 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)] Marking BS 1704:1985 on or in relation to a product is a claim by the manufacturer that the product has been manufactured to the requirements of the standard. The accuracy of such a claim is therefore solely the manufacturer's responsibility. Enquiries as to the availability of third party certification to support such claims should be addressed to the Director, Quality Assurance Division, BSI, PO Box 375, Milton Keynes MK14 6LO for certification marks administered by BSI or to the appropriate authority for other certification marks.

0 Introduction

Although the thermometers covered by this International Standard are not intended for use in any specific test method, the overall lengths of the series of higher accuracy are specified with a tolerance so as to provide a degree of interchangeability for any special apparatus into which the thermometers are incorporated.

For ease of reference, each thermometer has been allocated a designation consisting of a single letter representing the range of the thermometer and the indication "TOTAL" or, for example, "75" relating to the intended immersion.

Some of the thermometers described in the scope and field of application of this International Standard, and which are in current use, are of a lower quality than those strictly covered in ISO 386. Accordingly, whilst this International Standard is based on the provisions of ISO 386, it does not align with those which recommend the distance between consecutive scale lines to be greater than 0,8 mm and the maximum error to be one scale division. In order to avoid increasing the cost of the thermometers, some of the dimensions recommended to be specified in ISO 386 have also been omitted.

1 Scope and field of application

This International Standard specifies requirements for two series of inexpensive "commercial quality" liquid-in-glass thermometers of the solid-stem type suitable for general purpose use in industry, schools and laboratories when great accuracy of measurement is not required:

a) a series designated A to H, in which nominal ranges and maximum overall lengths are specified but which may not be acceptable for testing by a national verification laboratory;

b) a series designated J to W of greater accuracy than in a) and with specified ranges and a tolerance on overall length, which may be acceptable for testing by a national verification laboratory.

The temperature range covered by each series is from – 100 °C to + 500 °C.

2 Reference

ISO 386, *Liquid-in-glass laboratory thermometers — Principles of design, construction and use.*

3 Temperature scale

The thermometers shall be graduated in accordance with the Celsius scale as defined in the current definition of the International Practical Temperature Scale (IPTS) adopted by the Conférence générale des poids et mesures, and in accordance with the International System of Units (SI).

4 Immersion

4.1 The thermometers shall be adjusted for use either at total immersion (i.e. the reading shall be correct when the thermometer is immersed so that the top of the liquid column is in the same plane as, or no more than two scale divisions above, the surface of the medium the temperature of which is required to be measured), or for partial immersion, as required.

4.2 In the latter case, the preferred immersion is 75 ± 1 mm, and the adjustment of such a thermometer shall be carried out at the average emergent liquid column temperature detailed in Table 1 and Table 2.

NOTE 1 Adjustment at partial immersion is not permitted for the thermometers with a scale extending below – 38 °C, because of the large errors likely to be caused in a spirit-in-glass thermometer by variations in temperature around the emergent portion of the stem.

NOTE 2 For guidance on the determination of the emergent liquid column corrections to be applied when the thermometer is used in situations where the average emergent liquid column temperature differs from that given in Table 1 and Table 2, see annex **B.6** and **B.7** of ISO 386.

5 Glass

The thermometer bulb shall be made of suitable thermometric glass.[2)] The glass or glasses comprising the thermometer shall be selected and processed so that the finished thermometer shows the following characteristics.

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

b) The bulb glass shall be stabilized by suitable heat treatment to ensure that the accuracy requirements of clause **10** are met.

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

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

[2)] An International Standard (ISO 4795) dealing with glasses for thermometer bulbs is in preparation.

6 Liquid filling

6.1 Mercury shall be used as liquid filling except for thermometers with a scale extending below – 38 °C for which a filling of an organic liquid shall be used which will remain liquid throughout the temperature range under the pressures prevailing inside the thermometer.

6.2 The organic liquid used as the liquid filling should preferably be coloured by means of a light-fast dye which does not stain the glass.

6.3 The organic liquid used as the liquid filling should preferably be toluene or an isomer or suitable mixture of isomers of pentane.

7 Gas filling

Thermometers containing mercury as the liquid filling shall be filled with a dry inert gas above the liquid filling. The pressure of the gas shall be high enough to raise the boiling point of the liquid sufficiently to minimize vaporization over the nominal range of the thermometer.

8 Construction

8.1 Shape

The thermometers shall be straight. Their external cross-section should be approximately circular, but if required, an external lens-shaped deviation from the circular cross-section is permitted to facilitate reading.

8.2 Top finish

The top of the thermometer shall be finished with a plain top, button top or glass ring. In all cases, the diameter of the top finish of the thermometer shall not exceed that of the stem.

8.3 Capillary tube

The capillary tube should preferably incorporate an enamel back. The inside of the capillary tube shall be smooth in order to avoid possible sticking of the liquid filling.

For the thermometers listed in Table 2, the cross-sectional area of the bore shall not show variations from the average greater than 10 %.

8.4 Expansion volume (safety chamber)

8.4.1 An expansion volume shall be provided at the top of the capillary tube. This volume may take the form either of an extension of the bore or of an expansion chamber.

NOTE Overheating a thermometer beyond its upper nominal limit is liable to change the zero or other fiducial point of the thermometer, and a redetermination of this point will therefore become necessary if it takes place.

8.4.2 If an expansion chamber is incorporated, it shall, except when the stem is made from borosilicate glass, be pear-shaped with the hemisphere at the top.

8.5 Enlargement of bore

There shall be at least 10 mm of unchanged capillary between any enlargement and the nearest scale line or immersion line.

8.6 Dimensions

The dimensions of the thermometers shall be as detailed in Table 1 and Table 2.

The tolerance on the overall length of the thermometers of higher accuracy given in Table 2 shall be ± 10 mm.

The bulb diameter shall not exceed that of the stem.

9 Scale lines, immersion line and figuring

9.1 The nominal ranges, figuring and scale divisions of the thermometers shall be as detailed in Table 1 and Table 2.

9.2 The scale lines shall be clearly etched or otherwise durably marked and of uniform thickness not exceeding the values given in Table 1 and Table 2. The lines shall be at right angles to the axis of the thermometer. Typical schemes of graduation and figuring are shown in the Figure.

9.3 In the case of the thermometers listed in Table 1 with 0 °C as the lower nominal limit or 100 °C as the upper nominal limit, the scale shall be extended by at least three divisions beyond each of these limits. In all other cases, the scales may also be suitably extended beyond the nominal limits.

9.4 On thermometers adjusted for partial immersion the immersion depth shall be indicated by a line on the stem at the appropriate distance from the bottom of the bulb (see clause **4**). This line shall be marked around the back of the thermometer and shall not cross the scale.

9.5 In the case of etched scales, the pigment filling shall remain in the scale lines, figures, inscriptions and immersion line under normal conditions of use.

10 Accuracy

The instrument error for the thermometers shall not be greater than the values given in Table 1 and Table 2.

NOTE In the case of thermometers of ranges 0 to 360 °C and 0 to 500 °C, an appreciable error may develop after long exposure at temperatures in the upper part of the scale range.

11 Inscriptions

11.1 The following inscriptions shall be durably and legibly marked on the thermometers:

a) unit of temperature: abbreviation of the name Celsius, for example "C", or the symbol "°C";

b) the designation of the thermometer;

c) for partial immersion thermometers, an indication of the immersion depth for which the thermometer is adjusted, for example "75 mm". No inscription is required for total immersion thermometers;

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

e) the number of this International Standard, i.e. ISO 1170, or the number of the corresponding national standard;

f) identification of the bulb glass, preferably by means of a coloured stripe or stripes, or by an inscription on the thermometer;

11.2 In addition to **11.1** if the purchaser requires the thermometer to bear an identifying number, the following inscription shall also be durably and legibly marked on the thermometer:

manufacturer's identification or serial number, the last two digits of which should indicate the year of manufacture.

Table 1 — Requirements for solid-stem general purpose thermometers for measurements of lower accuracy

Nominal range	Scale division	Longer lines at each	Line thickness	Fractional figuring at each	Full figuring at each	Overall length	Scale length (nominal range)	Total immersion	Partial immersion		Designation (The immersion is added as appropriate, for example, "/75")
			max.			max.	min.	Maximum error	Maximum error	Average emergent liquid column temperature	
°C	°C	°C	mm	°C	°C	mm	mm	°C	°C	°C	
− 100 to + 30	1	5	0,25	—	10	305	180	2	[a]	[a]	A
− 35 to + 30	0,5	1	0,25	5	10	305	180	1	1,5	20	B
0 to + 60	0,5	1	0,25	5	10	305	180	0,5	0,5	20	C
0 to + 100	1	5	0,25	—	10	305	180	1	1,5	35	D
0 to + 160	1	5	0,25	10	100	305	180	2	3	35	E
0 to + 250	1	5	0,20	10	100	305	180	2	3	35	F
0 to + 360	2	10	0,20	20	100	305	180	4	6	50	G
0 to + 500	5	10	0,25	50	100	350	180	10	15	75	H

[a] Graduation for partial immersion is not permitted for these thermometers (see note 1 in clause **4**).

Table 2 — Requirements for solid-stem general purpose thermometers for measurements of higher accuracy

Range	Scale division	Longer lines at each	Line thickness max.	Fractional figuring at each	Full figuring at each	Overall length	Scale length min.	Total immersion	Partial immersion		Designation (The immersion is added as appropriate, for example, "/75")
								Maximum error	Maximum error	Average emergent liquid column temperature	
°C	°C	°C	mm	°C	°C	mm ± 10	mm	°C	°C	°C	
– 100 to + 50	1	5	0,25	10	100	305	200	2	[a]	[a]	J
– 50 to + 50	1	5	0,25	—	10	305	150	2	[a]	[a]	K
– 1 to + 51	0,1	0,5	0,10	1	10	460	300	0,3	1	20	L
– 1 to + 101	0,1	0,5	0,10	1	10	610	500	0,3	1	35	M
– 1 to + 201	0,2	1	0,25	2	10	610	500	0,4 °C to 100 °C 0,5 °C above 100 °C	1 °C to 100 °C 1,5 °C above 100 °C	35	N
– 35 to + 50	1	5	0,25	—	10	305	200	0,5	1	20	P
– 20 to + 110	1	5	0,25	—	10	305	200	0,5	1	35	R
– 20 to + 150	1	5	0,20	10	100	305	200	0,5	1	35	S
– 10 to + 260	1	5	0,20	10	100	405	250	0,5 °C to 100 °C 1 °C above 100 °C	1 °C to 100 °C 1,5 °C above 100 °C	35	T
– 10 to + 400	2	10	0,25	20	100	405	250	2 °C to 300 °C 4 °C above 300 °C	2,5 °C to 300 °C 5 °C above 300 °C	50	V
– 10 to + 500	2	10	0,20	20	100	405	250	2 °C to 300 °C 4 °C above 300 °C	2,5 °C to 300 °C 5 °C above 300 °C	75	W

[a] Graduation for partial immersion is not permitted for these thermometers (see note 1 in clause **4**).

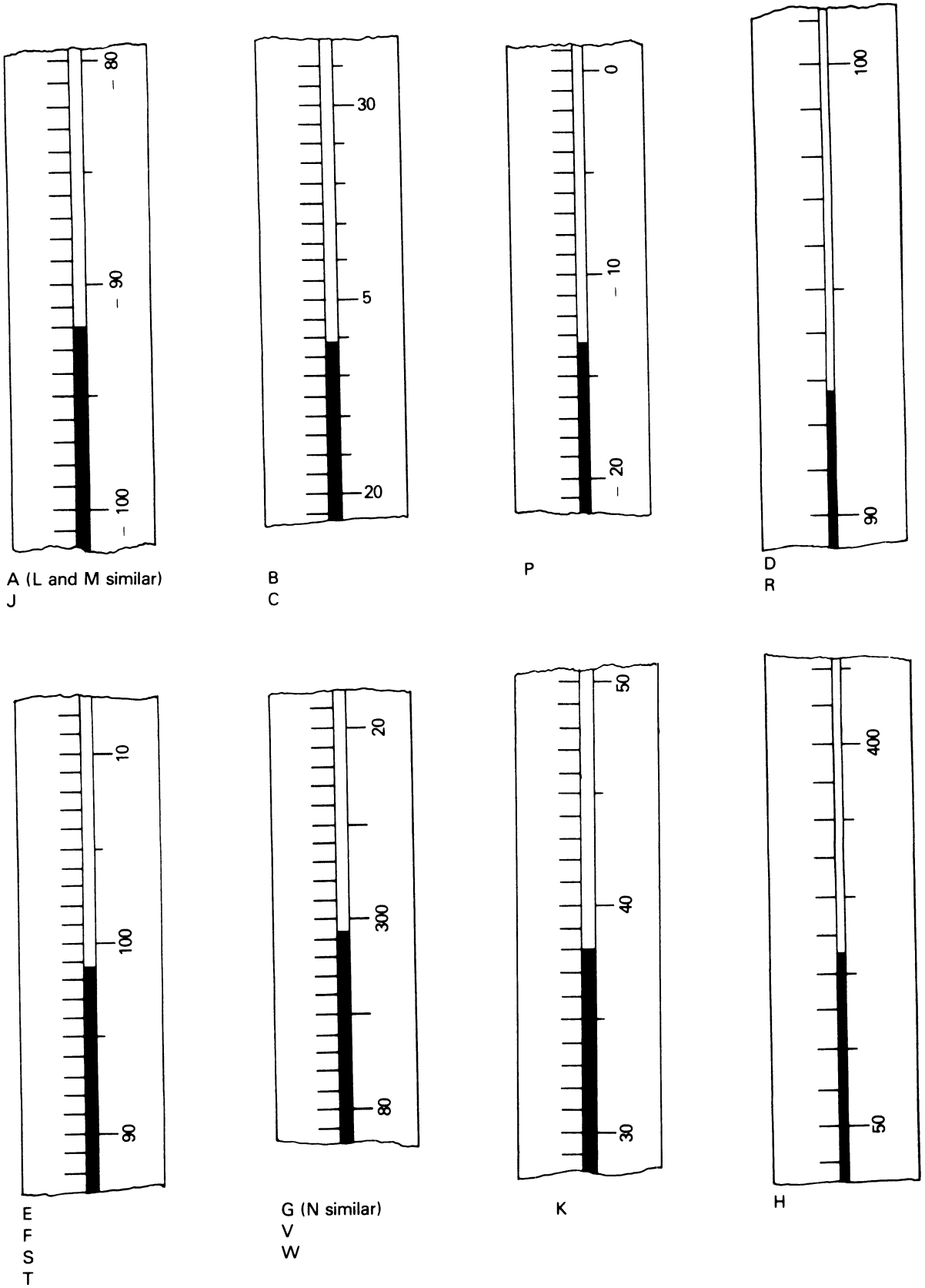

Figure — Examples of scale lines and figuring

National appendix A Testing of British Standard thermometers

Depending upon the test temperature range involved, the British Standards Institution at its Hemel Hempstead Centre or the National Physical Laboratory are prepared to examine laboratory thermometers for compliance with the requirements of this British Standard. Satisfactory thermometers are marked with the letters BST or NPL and the year of the test. Testing arrangements and particulars of fees can be obtained on application to The Director, Testing Services Division, British Standards Institution, Maylands Avenue, Hemel Hempstead, Herts HP2 4SQ, or The Director, National Physical Laboratory, Teddington, Middlesex TW11 0LW.

It is desirable that thermometers be retested at intervals not exceeding five years, or more frequently if determinations at a reference point indicate that a 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 uncertainty of test for certification of the thermometers together with the testing centre to which a thermometer should be submitted.

Table 3 — Uncertainty of test for certification of British Standard general purpose thermometers

Designation	Total immersion thermometers		Partial immersion thermometers	
	Uncertainty of test	Tested by	Uncertainty of test	Tested by
	°C		°C	
J	± 0.5	BSI and NPL		
K	± 0.2	BSI		
L	± 0.02	BSI	± 0.05	BSI
M	± 0.02	BSI	± 0.05	BSI
N	± 0.05	BSI and NPL	± 0.1	BSI and NPL
P	± 0.2	BSI	± 0.5	BSI
R	± 0.1	BSI	± 0.2	BSI
S	± 0.2	BSI and NPL	± 0.2	BSI and NPL
T	± 0.2	BSI and NPL	± 0.2	BSI and NPL
V	± 1	NPL	± 1	NPL
W	± 1	NPL	± 1 (± 2 at 500 °C)	NPL

Publication referred to

See national foreword.

BSI certification marks

A licence to use the Kitemark or "Safety Mark" on or in relation to a product will be granted to any manufacturer or producer who demonstrates that he can and will be able consistently to make that product to the requirements specified in the British Standard product specification. His capability of doing so is initially established by assessment of his production process, quality control organization and test facilities against the required Part of BS 5750 "*Quality systems*", and by testing the product against all the criteria of the relevant standard. The licensee is required to document for BSI the Quality Plan setting out his specific quality practices, resources and activities relevant to achieving compliance with the product standard. BSI carries out unannounced inspection visits to the manufacturer's works and audit testing of the product, and may withdraw the licence for any failure of the manufacturer to comply with the relevant standard. The presence of the mark on or in relation to a product is an assurance that the goods have been produced under an independently assessed quality system and have been subject to testing and the periodical inspection of the manufacturer's works in accordance with the certification trade mark regulations of BSI.

The Kitemark

The 'Safety Mark'

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