BRITISH STANDARD

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Specification for

Meteorological thermometers

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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

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Contents

Foreword

This British Standard has been prepared under the direction of the Laboratory Apparatus Standards Policy Committee and supersedes BS 692:1976 which is withdrawn.

This British Standard was first published in 1936 and revisions were issued in 1951, 1958 and 1976. This revision introduces technical changes to bring the standard up to date and in particular changes to the availability of glasses and arrangements for calibration and testing.

This revision reflects the change to the Celsius scale for all Meteorological Office observations and all dimensions are given in metric units. Any continuing requirement for thermometers with a Fahrenheit scale is catered for in Appendix D.

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 range of meteorological thermometers comprises the following types.

thermometers protected by glass sheaths and suitable for mounting in a louvred screen (see Figure 1).

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

2 Types

This British Standard range of meteorological thermometers comprises the following types.

a) **Maximum.** Mercury-in-glass, graduated on the stem, with as high a vacuum as possible above the mercury.

b) **Minimum.** Spirit-in-glass, graduated on the stem.

c) **Ordinary** (i.e. wet or dry bulb). Mercury-in-glass (except for Ord. 4 which shall be spirit-in-glass), graduated on the stem.

3 Temperature scale

The temperature scale to which this specification refers is 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). The Fahrenheit scale values in this British Standard are derived from the Celsius scale.

4 Stem

The stem shall be of lead glass or other thermometric glass appropriate to the temperature range, with an enamel back.

5 Bulb

The bulb for ordinary thermometers shall be substantially spherical, with its centre approximately in alignment with the axis of the stem. The bulb for maximum and minimum thermometers shall be either spherical or cylindrical. The bulb shall be of the thermometric glass approved by the National Physical Laboratory (see Appendix A).

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 thermometer shall be stabilized before graduation using a process such that the maximum error and interval error of the finished thermometer are within the limits specified in Table 2.

8 Immersion

The thermometer shall be graduated for complete immersion.

9 Scale lines

The scale lines shall be clearly etched or otherwise durably marked at each 0.5 °C and shall be of uniform thickness not exceeding 0.15 mm. The lines shall lie in planes at right angles to the axis of the thermometer, and their left hand ends shall be on an imaginary line parallel with the axis of the thermometer. When the thermometer is held vertically so that the enamel back forms a suitable background to the scale lines and figuring, the long and medium lines shall extend to the right, but the shortest lines shall not extend across the bore.

10 Figuring

The thermometers shall be figured at each 5 °C in bold figures of uniform thickness.

The figures for ordinary thermometers shall be upright when the thermometer is held in a vertical position and viewed from the front and shall be placed so that each would be intersected by the line to which it refers if the line were extended. All negative figures shall have a minus sign placed above them.

The figures for maximum and minimum thermometers shall be upright when the thermometer is held in a horizontal position with the bulb to the left and viewed from the front, and shall be placed so that they would be bisected by the line to which they refer if the line were extended. All negative figures shall have a minus sign placed before them.

NOTE Figure 2 illustrates diagrammatically the graduation and figuring specified for typical thermometers.

All scale lines and figures shall be durably marked in black.

11 Construction

Each thermometer shall comply in all respects with the dimensions given in Table 1. The ranges and tolerances shall be in accordance with Table 2.

Table 1 — Dimensions for meteorological thermometers

Dimensions	Type		
	Ordinary	Maximum	Minimum
	mm	mm	mm
Overall length	315 to 330	315 to 345	315 to 345
Length of scale, min.	190	190	190
Stem diameter	5 to 6.5	5 to 6.5	5 to 6.5
Length of parallel portion of bore above and below scale, min.	10	10	10
Bulb diameter:			
spherical type	Ord. 1, Ord. 2, Ord. 3: 8.5 to 11.5 Ord. 4: 11.5 to 14	8.5 to 11.5	Not greater than 16.5
cylindrical type	—	Not greater than stem diameter	Not greater than stem diameter
Distance from bottom of bulb to bottom of scale, min.	50	50	50

Table 2 — Ranges and tolerances for meteorological thermometers (Celsius scale)

Designation	Filling	Range	Maximum error at any point				Maximum error in an interval of 10 °C (see note 2)		
			Below – 40 °C	– 40 °C to below 0 °C	0 °C to 25 °C	Above 25 °C	Below 0 °C	0 °C to 25 °C	Above 25 °C
		°C	°C	°C	°C	°C	°C	°C	°C
Ord. 1/C	Mercury	– 20 to + 55	—	– 0.3 + 0.2	– 0.2 + 0.05	– 0.2 + 0.05	0.25	0.1	0.1
Ord. 2/C	Mercury	– 30 to + 45							
Ord. 3/C	Mercury	– 40 to + 35							
Ord. 4/C	Spirit	– 55 to + 20	± 0.6	± 0.25	± 0.1	—	0.25	0.1	—
Max. 1/C	Mercury	– 10 to + 65	—	– 0.3 + 0.2	– 0.2 + 0.05	– 0.2 + 0.05	0.25	0.1	0.1
Max. 2/C	Mercury	– 20 to + 55							
Max. 3/C	Mercury	– 30 to + 45							
Max. 4/C	Mercury	– 40 to + 35							
Min. 1/C	Spirit	– 25 to + 50	—	± 0.25	± 0.1	± 0.25	0.25	0.1	0.25
Min. 2/C	Spirit	– 35 to + 40							
Min. 3/C	Spirit	– 50 to + 25	± 0.6	± 0.25	± 0.1	—	0.25	0.1	—
Min. 4/C	Spirit	– 70 to + 15							

NOTE 1 The range of the Ord. 3/C and the Max. 4/C thermometers extends down to – 40 °C, because the mercury usually remains liquid at this temperature due to supercooling below its freezing point of – 38.8 °C.

NOTE 2 The maximum error in an interval of 10 °C refers to the algebraic difference between the errors at opposite ends of the interval, i.e. 0.1 °C means that the change of error in any interval of 10 °C does not exceed 0.1 °C.

NOTE 3 The tolerance for the mercury-in-glass thermometers permit greater minus errors than plus errors in order to allow for the tendency of the zero of these thermometers to rise slowly with time.

12 Sheath

The outer glass sheath shall be of lead glass or other thermometric glass appropriate to the temperature range, hermetically sealed to the stem at a point near the bulb. The sheath shall be not more than 14 mm in external diameter except at the point where the sheath is rejoined after graduation. No visible distortion of the scale shall be caused at this point. There shall be no excess diameter on the ordinary thermometer within 270 mm of the underside of the button. The top end of the stem shall be securely supported inside the sheath by a ring of rubber or cork, not exceeding 4 mm in width, fitted inside the sheath and over the stem and placed so as not to obscure the graduated scale, the safety chamber or the end of the bore.

If one or two similar supports are placed in a position between the seal and the bottom of the scale this shall not obscure the constriction of the maximum thermometer. The thermometer shall be so constructed that no visible condensation occurs inside the sheath when the thermometer is exposed to any temperature within its working range. If cork is used for the supporting ring(s) it shall be thoroughly dried before fitting.

13 Top finish

Each ordinary thermometer shall be finished in the form of a button, as shown in Figure 3, which shall be of such size as to enable the thermometer to be easily and securely suspended from the clip shown in Figure 4, and shall allow it to be withdrawn from the clip when in a vertical position.

The maximum and minimum thermometers shall be finished with a plain top.

14 Expansion chamber

The thermometers shall be so constructed as to withstand without damage a temperature of 50 °C or at least 3 °C above that shown by the highest scale line, whichever is the higher temperature. There shall be no safety chamber or enlargement of the bore in the maximum thermometers, except if a pear-shaped expansion volume with the hemisphere at the top is provided in the ordinary and minimum thermometers. There shall be at least 10 mm of unchanged capillary tube above the highest scale line.

15 Spirit filling

The spirit shall be absolute ethanol (ethyl alcohol) containing not less than 99.4 % (*V*/*V*) i.e. 99.0 % (*m*/*m*) of ethanol, and having a density at 20 °C not greater than 0.7921 g/cm^3.

The ethanol shall comply in other respects with the provisions of BS 507, subject to the following modifications.

a) *Aldehydes and ketones.* The ethanol when tested in accordance with BS 6392-3 shall not contain more than 0.02 % (*m*/*m*) of aldehydes and ketones, calculated as acetaldehyde, CH_3CHO.

b) *Esters.* The ethanol, when tested in accordance with BS 6392-8, shall not contain more than 0.02 % (*m*/*m*) of esters, calculated as ethyl acetate, $CH_3COOC_2H_5$.

c) *Amines.* The ethanol, when tested in accordance with Appendix C, shall give no indication of the presence of amines.

16 Maximum and minimum thermometers: special provisions

The maximum thermometer shall have a constriction situated in the bore below the lowest scale line so that as the temperature falls the mercury column is not drawn back past the constriction when the thermometer is inclined at an angle of 10° or less to the horizontal with the bulb at the lower end. The mercury shall shake through the constriction without undue effort when the thermometer is being re-set.

The construction shall be such as to reduce as far as possible the tendency of the mercury column to draw away from the constriction when the thermometer in the normal position of use, i.e. inclined at an angle of about 2° to the horizontal with the bulb at the lower end, is subject to vibration such as might be caused by opening the door of the screen.

The minimum thermometer shall be provided with an index of dark glass in the bore. The length of this index shall be about 20 mm but in the case of cylindrical bulbs, it shall be at least 5 mm greater than the length of the bulb. The construction shall be such that the thermometer acts as a minimum thermometer when mounted at an angle of about 2° to the horizontal with the bulb at the lower end.

17 Inscriptions

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

a) The official symbol "°C": An abbreviation of the name Celsius, e.g. "C" is also permitted. (See also Appendix D for the inscription of Fahrenheit thermometers.)

b) An identification number.

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

d) The designation: the code reference allotted to the thermometer, e.g. "Ord. I/C".

e) The number of this British Standard, i.e. BS 692[1)].

[1)] Marking BS 692 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 Thermometric glasses approved by the National Physical Laboratory

The following table lists the identification mark(s) of all glasses that have been approved as suitable 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-N 16	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 meteorological 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).

Appendix C Method of test for the absence of amines in spirit filling

To 10 mL of the ethanol add 10 mL of distilled water and 2 drops of a saturated solution of *p*-nitrophenol in water. Not more than 0.05 mL (1 drop) of H_2SO_4 $c(\frac{1}{2}H_2SO_4)$ = 0.1 mol/L shall be required to discharge any yellow colour produced.

Appendix D Meteorological thermometers with a Fahrenheit scale

The details specified for Celsius scale thermometers apply to Fahrenheit scale thermometers except as follows.

Scale lines. Scale lines shall be at each 1 °F with longer lines at each 5 °F.

Figuring. Figuring shall be at each 10 °F.

Constructional details. The ranges and tolerances shall be in accordance with Table 4.

Expansion chamber. The thermometers shall be so constructed as to withstand without damage a temperature of 120 °F or at least 5 °F above that shown by the highest scale line, whichever is the higher temperature.

Marking. Each thermometer shall be permanently and legibly marked with the letter F to indicate that the Fahrenheit scale is employed.

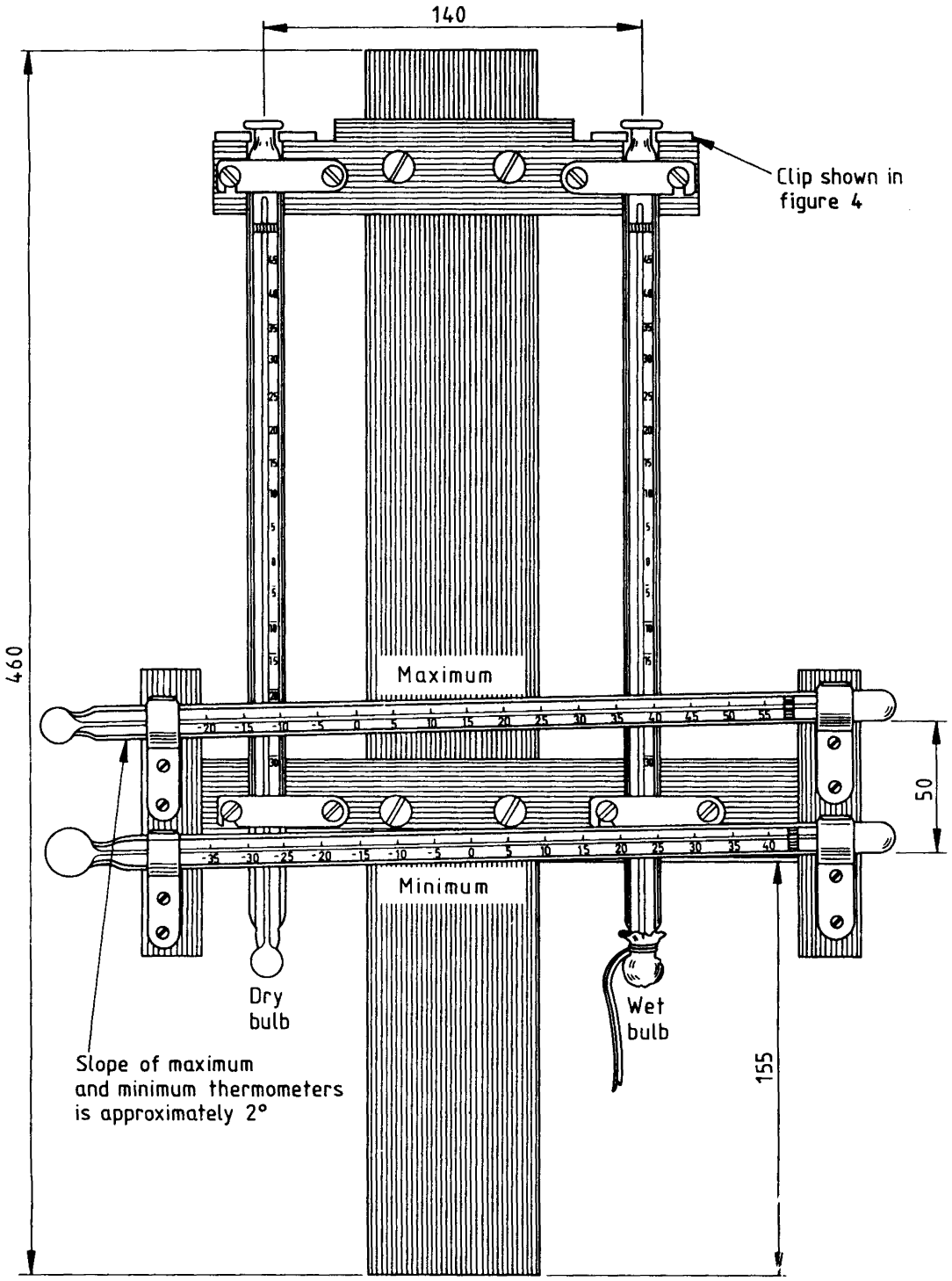
Table 4 — Ranges and tolerances for meteorological thermometers (Fahrenheit scale)

Designation	Filling	Range	Maximum error at any point				Maximum error in an interval of 20 °F (see note 2)		
			Below – 40 °F	– 40 °F to below + 32 °F	+ 32 °F to 80 °F	Above 80 °F	Below 32 °F	32 °F to 80 °F	Above 80 °F
			°F	°F	°F	°F	°F	°F	°F
Ord. 1/F	Mercury	0 to 130	—	– 0.5 + 0.3	– 0.3 + 0.1	– 0.3 + 0.1	0.4	0.2	0.2
Ord. 2/F	Mercury	– 20 to + 110							
Ord. 3/F	Mercury	– 40 to + 90							
Ord. 4/F	Spirit	– 60 to + 70	± 1.0	± 0.4	± 0.2	—	0.4	0.2	—
Max. 1/F	Mercury	15 to 145	—	– 0.5 + 0.3	– 0.3 + 0.1	– 0.3 + 0.1	0.4	0.2	0.2
Max. 2/F	Mercury	0 to 130							
Max. 3/F	Mercury	– 20 to + 110							
Max. 4/F	Mercury	– 40 to + 90							
Min. 1/F	Spirit	– 10 to + 120	—	± 0.4	± 0.2	± 0.4	0.4	0.2	0.4
Min. 2/F	Spirit	– 30 to + 100							
Min. 3/F	Spirit	– 50 to + 80	± 1.0	± 0.4	± 0.2	—	0.4	0.2	—
Min. 4/F	Spirit	– 90 to + 60							

NOTE 1 The range of the Ord. 3/F and the Max. 4/F thermometers extends down to – 40 °F, because the mercury usually remains liquid at this temperature due to supercooling of the mercury below its freezing point of – 37.9 °F.

NOTE 2 The maximum error in an interval of 20 °F refers to the algebraic difference between the errors at opposite ends of the interval, i.e. 0.2 °F means that the change of error in any interval of 20 °F does not exceed 0.2 °F.

NOTE 3 The tolerances for the mercury-in-glass thermometers permit greater minus errors than plus errors in order to allow for the tendency of the zero of these thermometers to rise slowly with time.



All dimensions are in millimetres.

Figure 1 — Suitable support for thermometers in a louvred screen

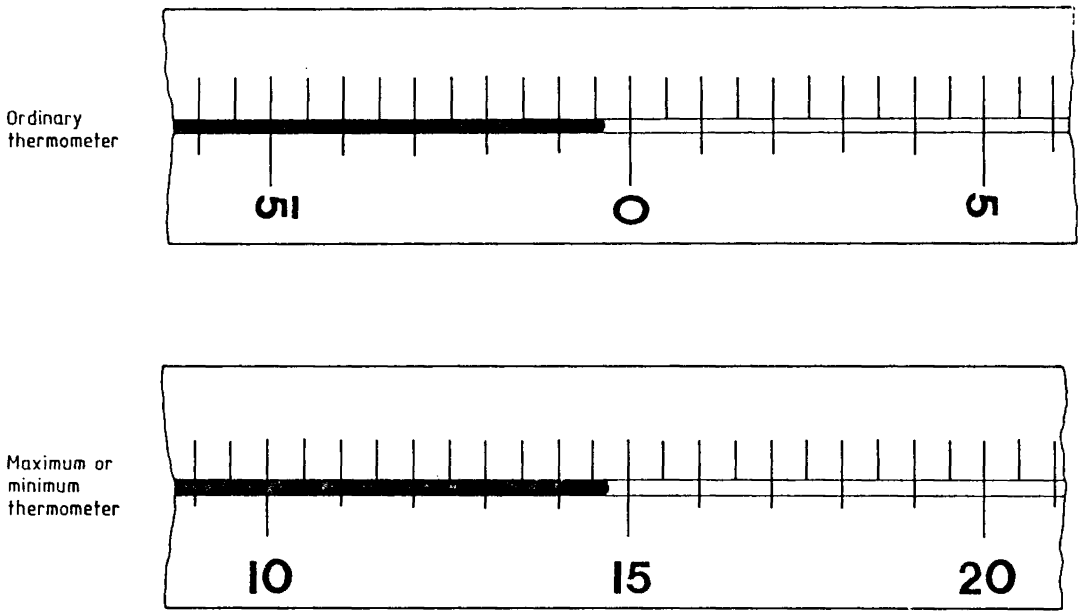
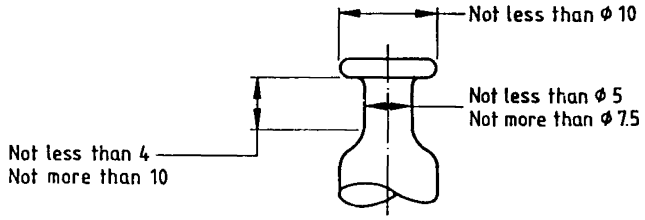
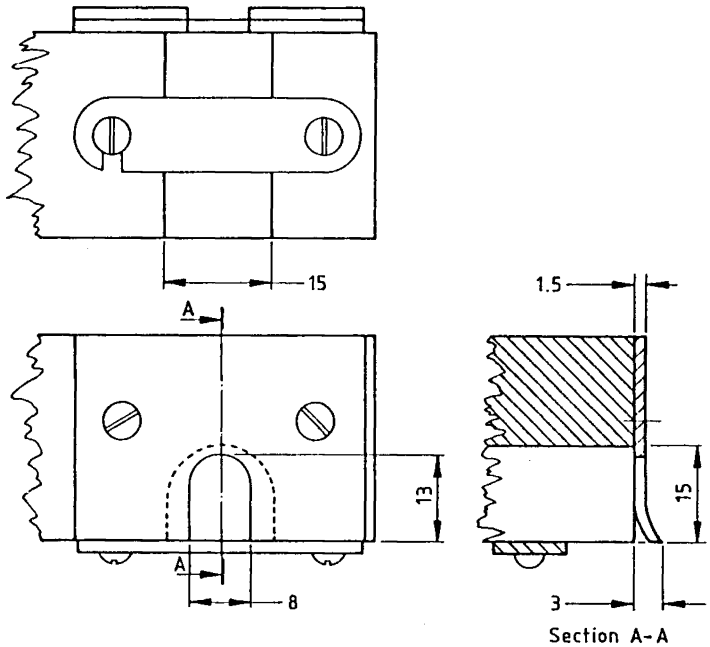


Figure 2 — Typical graduation and figuring for British Standard Celsius meteorological thermometers



All dimensions are in millimetres.

Figure 3 — Details of button at top of ordinary thermometer



All dimensions are in millimetres.

Figure 4 — Details of clips on thermometer support

Publications referred to

BS 507, *Specification for ethanol for industrial use.*

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

BS 6392, *Testing of ethanol for industrial use.*

BS 6392-3, *Method for determination of carbonyl compounds content present in moderate amounts (titrimetric method).*

BS 6392-8, *Method for determination of esters content.*

[2)] Referred to in the foreword only.

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