BRITISH STANDARD

BS 2842:1992

CONFIRMED
DECEMBER 2007

Specification for

Whirling hygrometer

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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/36, upon which the following bodies were represented:

Association for Science Education
British Glass Manufacturers' Confederation
British Laboratory Ware Association
CLEAPSS School Science Service
Department of Trade and Industry (Laboratory of the Government Chemist)
Institute of Medical Laboratory Science

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

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

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Foreword

This British Standard has been prepared under the direction of the Laboratory Apparatus Standards Policy Committee, and supersedes BS 2842:1975 which is withdrawn.

This British Standard is one of a series prepared at the request of the Temperature Measuring Instruments Sub-committee (since disbanded) of the Defence Materials Standardisation Committee of the Ministry of Defence. It is intended to cover the Service requirements for this type of hygrometer as well as the requirements of commercial users. This standard was first published in 1957, with the title *Whirling hygrometer (medium size).* It was revised in 1966 to permit a wider range of bulb diameters, to specify an alternative thermometer with a plain front, and to relax the dimensional requirements for the button top.

Experience in using the whirling hygrometer specified in the 1966 edition showed that the figures for maximum error given in Table 2 understated the actual error values.

The 1975 edition specified a larger hygrometer incorporating a longer thermometer of improved design to overcome the inaccuracy. At the same time, the increased length was to allow a single thermometer with an extended temperature range to be used.

Though more accurate, the 1975 larger model was never produced. Consumers demanded manufacture of the smaller 1966 medium size model. In response to this demand the present standard reinstates the medium size model, but with realistic revised error figures.

Thermometers with a Fahrenheit scale have not been included in this revision. In order to avoid confusion between the various revisions of this specification, the thermometers now specified are to be marked to indicate the year of issue of this British Standard.

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

The whirling hygrometer is used, in conjunction with appropriate relative humidity tables (see Annex B), for the determination of the temperature and relative humidity of the air. Annex C indicates, for each hygrometer, the size of errors in relative humidity arising from thermometer errors. Figure 1 illustrates the general design of the hygrometer, but the details shown are not to be taken as being requirements of this British Standard except as indicated in the text.

When wet-bulb and dry-bulb measurements of humidity of a higher precision are required, an aspirated hygrometer conforming to BS 5248:1990 should be used.

NOTE For accurate determination of humidity, hygrometers of the whirling or aspirated type are not recommended for use in isolation from other, more direct means of measurement.

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 product 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 are 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 to iv, 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.

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Section 1. General

1.1 Scope

This British Standard specifies requirements for thermometers suitable for use in whirling (sling) hygrometers, together with sufficient details of the other parts of the instrument to ensure that the thermometers are interchangeable in the frames.

1.2 Informative references

This British Standard refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

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Section 2. Thermometers

2.1 Types

The thermometers shall be of the mercury-in-glass, gas-filled, solid-stem type, with a lens magnifying front and a button top. They shall be graduated for complete immersion, i.e. to give correct readings when wholely immersed in the medium whose temperature is being measured.

NOTE It is recommended that there be a slight neck, to allow a closely fitting cylindrical absorbent sleeve of suitable type to be fitted securely to the bulb.

2.2 Temperature scale

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

2.3 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 **2.8**.

2.4 Material

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

NOTE To reduce the likelihood of fracture due to mechanical or thermal shock, all the glass should be annealed following any high temperature treatment during manufacture.

2.5 Range

The nominal ranges of the thermometers shall be

– 15 °C to + 40 °C

– 5 °C to + 50 °C

+ 10 °C to + 65 °C.

2.6 Dimensions

The thermometers shall conform to the dimensions given in Table 1.

Table 1 — Dimensions for thermometers

Dimensions in millimetres

Overall length	164 to 168
Scale length	80 to 108
Bulb length	15 to 22
Bulb diameter (max.)	5.5
Stem diameter (max.)	5.5
Distance from bottom of bulb to lowest scale line (min.)	38
Button top diameter	6 to 8
Button top thickness (min.)	1.5

2.7 Graduation and figuring

2.7.1 Scale lines

The thermometers shall be graduated at each 0.5 °C, with a longer line at each 1 °C. The lines at each 5 °C shall be extended further. The scale lines shall be fully numbered at each 5 °C. The shorter scale lines shall extend towards the magnified image of the mercury column formed by the lens front, so that the thermometer is easily readable. All scale lines and figures shall be legibly etched or otherwise durably marked. The thickness of the lines shall not exceed 0.2 mm.

2.7.2 Figuring

The figures shall be upright when a thermometer is held in a horizontal position and viewed from the front with the bulb to the left, and shall be placed symmetrically below the lines to which they refer.

2.8 Accuracy

The reading of a thermometer shall not be in error by more than 0.3 °C, at any point on the scale when the thermometer is completely immersed.

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2.9 Expansion chamber

The thermometers shall be so constructed as to withstand a temperature of 20 °C above the maximum temperature on the thermometer scale without damage. To enable the thermometers to withstand this temperature an expansion chamber, which shall be pear-shaped with a hemispherical top, shall be visible in the frame. This chamber shall not be obscured by any part of the thermometer clamping assembly. There shall be at least 5 mm of unchanged capillary tube above the highest scale line.

2.10 Marking

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

a) The official symbol "°C", or an abbreviation of the name Celsius such as "C".

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

c) An identification number, e.g. a batch number.

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

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

f) The number and date of this British Standard, i.e. BS 2842:1992[1)].

[1)] Marking BS 2842:1992 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 solely the claimant's responsibility. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.

Section 3. Frame

3.1 Construction of frame

The frame of the hygrometer shall be of robust construction, manufactured from material of a type known to be stable within the temperature range of the thermometer. The design shall be such as to accept thermometers of stem diameter 5.5 mm and button top diameter 8 mm. The instrument shall be capable of being rotated at about 180 r/min when held in the hand and shall allow free passage of air past the two thermometer bulbs. The thermometers shall be held securely side by side with the whole length of the scales clearly visible. Means shall be provided to prevent the thermometers from rotating in the frame, and to enable the frame to be opened to permit replacement of the thermometers.

NOTE An example of the general design of a whirling hygrometer is shown in Figure 1.

3.2 Water container

The frame shall incorporate a water container, designed so that water cannot leak from it during use, in such a position that a short length of sleeve (see **A.1**) dipping into it can be fitted to the wet bulb thermometer.

At least 5 mm of sleeve below the bulb of the thermometer shall be exposed to the stream of air.

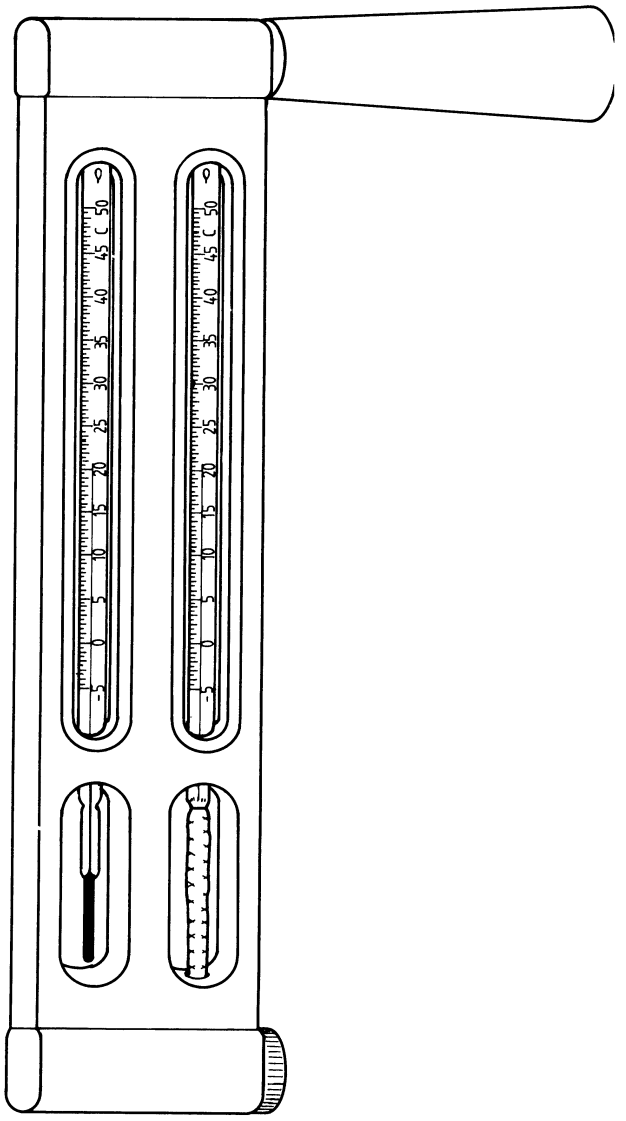

Figure 1 — Whirling hygrometer: example of general design

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Annex A (informative)
Method of use of whirling hygrometers

A.1 Apparatus

The whirling hygrometer consists of two mercury-in-glass thermometers mounted side by side in a frame which is provided with a handle and spindle so that the frame and thermometers can be rotated at approximately 180 r/min about a horizontal axis. The bulb of one of the thermometers is covered by a closely fitting cylindrical sleeve, the end of which dips into a small water container attached to the end of the frame. When the frame is rotated the thermometer bulbs pass through the air at a rate dependent on the speed of rotation. Provided the air velocity is sufficiently great, the wet bulb thermometer cools down to a constant (wet bulb) temperature due to the evaporation of water from the wet sleeve. Rotation for 30 s to 40 s is sufficient.

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 whirling (sling) or aspirated hygrometers (see Annex B).

A.2 Precautions

The following precautions are recommended.

a) The sleeve should be of a suitable width to fit tightly over the wet bulb and should be long enough to reach the bottom of the distilled water reservoir. The sleeve should not be of so tight a fit in the tube or hole of the water container that water is prevented from passing up the sleeve. 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 de-ionized water.

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

c) Only distilled or de-ionized water conforming to Grade 3 of BS 3978:1987 should be used for filling the water container.

d) The hygrometer should always be rotated in front and to windward of the observer. Observations should be taken in the shade in such a location as to minimize the effect of thermal radiation on the thermometers during the period of rotation and while they are being read.

e) In still air conditions it is advisable to walk forwards while whirling the hygrometer since the observer may set up local variations in humidity.

f) Care should be taken that when the instrument is being read, the observer's hands are kept away from the bulb; the observer should also take care not to breathe on the instrument.

g) It is particularly important that the wet bulb temperature be read first, immediately after whirling has ceased, because the temperature shown by the wet bulb tends to rise as soon as the instrument stops rotating.

h) 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 with a fine pointed object.

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

Annex B (informative)
Tables suitable for use with whirling hygrometers

Tables suitable for use with whirling hygrometers are given in:

Hygrometric tables for aspirated psychrometer readings in degrees Celsius, Part III, MO 265c, HMSO 1964 [2].

For further information see:

BS 1339:1965, *Definitions, formulae and constants relating to the humidity of the air.*

BS 4833:1986, *Schedule for hygrometric tables for use in the testing and operation of environmental enclosures.*

Annex C (informative)
Errors in computed relative humidity

C.1 In practice the accuracy of the measurement of relative humidity obtained with the whirling hygrometer is limited by the following factors.

a) The speed of rotation of the frame and thus the ventilation rate of the thermometer bulbs is determined by the observer and may be lower than the recommended speed of approximately 180 r/min.

b) When the rotation is stopped to read the thermometers the wet bulb thermometer temperature rises rapidly and error may arise through not reading the temperature quickly enough.

c) The design of the instrument does not allow the enclosure of the thermometer bulbs by thermal radiation shields. Hence variations in thermal irradiation of the bulbs can occur.

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d) The presence of the observer may affect the humidity of the air.

These sources of error can be eliminated or minimized by the use of an aspirated hygrometer (see BS 5248:1990).

C.2 Because the value of the relative humidity derived from the use of a wet and dry bulb hygrometer is obtained by measuring the difference in temperature between the two thermometers, the accuracy of this value is directly dependent on the errors of the thermometers.

This British Standard specifies that the thermometers shall not be in error by more than 0.3 °C at any point on the scale (see clause **2.8**). The maximum error in the difference between the wet and dry bulb thermometers is therefore 0.6 °C. The corresponding maximum errors, due solely to thermometer error, in the computed relative humidity are shown in the first section in Table C.1.

To these errors have to be added the error in reading the thermometers in the short time available which may be 0.2 °C. This may amount to an additional error of another 2 % to 8 % relative humidity, depending on the dry bulb temperature.

A higher accuracy may be achieved if the two thermometers, each being within the limits of accuracy specified, are also matched to within 0.3 °C. This is not practicable unless tables of errors are available.

The maximum errors in the computed relative humidity due solely to this thermometer error are shown in the second section of Table C.1.

The highest accuracy obtainable with the greatest flexibility in use is achieved by providing each thermometer with a National Measurement Accreditation Service (NAMAS) certificate of corrections. In this case, and if the appropriate corrections are applied to the readings, the maximum error in the difference between the wet and dry bulb thermometers should not exceed 0.1 °C.

Note that the additional possible error due to error in reading still applies.

C.3 At low humidities, that is when the wet bulb temperature is well below the dry bulb temperature, heat conduction down the stem to the wet bulb may be significant and this results in too high a wet bulb reading. In some circumstances this can amount to an error of up to 5 % relative humidity. In these circumstances it would be desirable to use a hygrometer incorporating enclosed-scale rather than solid-stem thermometers, or to use an aspirated hygrometer.

Table C.1 — Maximum error in computed relative humidity due to thermometer error

	Temperature of dry bulb °C					
	– 10	– 5	0	10	20	30
	Relative humidity in percent					
Using unmatched thermometers (maximum error 0.3 °C)	18	14	10	7	5	4
Using matched thermometers (matched to 0.3 °C)	9	7	5	4	3	2
NAMAS calibrated to ± 0.05 °C	3	2	2	1	1	1
If misread by up to 0.2 °C then add a **further**	11	9	7	5	4	3

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Annex D (informative) Thermometric glasses approved by the National Physical Laboratory

Table D.1 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 thermometers that predate this standard in the certification of both the bulb glass and the recommended working temperature ranges.

Annex E (informative) 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 OLW (telephone: 081-977 3222).

It is desirable that thermometers be retested at intervals not exceeding 5 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 D.1 — Identification stripe(s) or approved abbreviations and recommended maximum working temperature of all glasses that have been approved for the manufacture of thermometer bulbs

Glass	Supplier	Identification stripe(s) or approved abbreviation	Recommended 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 recommended 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"s of the thermometer.

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List of references (see clause 1.2)

Informative references

BSI standards publications

BRITISH STANDARDS INSTITUTION, London

BS 1339:1965, *Definitions, formulae and constants relating to the humidity of the air.*

BS 3978:1987, *Specification for water for laboratory use.*

BS 4833:1986, *Schedule for hygrometric tables for use in the testing and operation of environmental enclosures.*

BS 5248:1990, *Specification for aspirated hygrometer.*

Other references

[1] GREAT BRITAIN. *The International Temperature Scale of 1990.* London: HMSO, 1991.

[2] GREAT BRITAIN. *Hygrometric tables for aspirated psychrometer readings in degrees Celsius,* Part III, MO 265c. London: HMSO, 1964.

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