

**BUREAU OF INDIAN STANDARDS**

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*Draft Indian Standard*

**LIQUID-IN-GLASS SOLID-STEM REFERENCE  
THERMOMETERS — SPECIFICATION**  
(*Second Revision*)

*भारतीय मानक मसौदा*

**लिक्विड-इन-ग्लास सॉलिड-स्टेम रेफरेंस थर्मोमीटर — विशिष्टि**

(*दूसरा पुनरीक्षण*)

ICS 17.200.20

Glass, Glassware & Laboratoryware Sectional Committee, CHD 10

**Last date for Comments: 21 February 2024**

**FOREWORD**

*(Formal clause to be added later)*

This standard was originally published in 1968 under the title ‘Specification for laboratory and reference thermometers’. In view of the experience gained during the years in the fabrication of thermometers specified in it, the committee responsible for the preparation of the standard decided to revise it in 1982 restricting its scope to reference thermometers meant for use in calibrating liquid-in-glass thermometers. In the first revision, accordingly, thermometers of partial immersion type which was not used for reference purposes, were dropped and the dimensions of thermometers were modified.

In this second revision, new thermometric liquids in addition to the mercury along with their working temperature range have been specified. A sampling plan for lot testing has also been prescribed and several editorial changes such as inclusion of the Reference clause, Hindi Title, ICS no, BIS certification marking clause, etc. have also been incorporated.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Draft Indian Standard*  
**FOR LIQUID-IN-GLASS SOLID-STEM REFERENCE  
THERMOMETERS — SPECIFICATION**  
*(Second Revision)*

## 1 SCOPE

This standard specifies requirements for a basic series of liquid-in-glass solid-stem reference thermometers meant for use in calibration of thermometers.

## 2 REFERENCE

The standards given below contain provisions which through reference in this text, constitute provisions of and necessary adjuncts to this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated.

<i>IS No.</i>	<i>IS Title</i>
IS 2627: 1979	Glossary of terms relating to liquid - In - Glass thermometers ( <i>first revision</i> )
IS 4610: 1968	Specification for glass tubes for general purpose and reference thermometers
IS 6274: 1971	Method of calibrating liquid - In - Glass thermometers
IS 8787: 2018	Principles of design, construction and use of liquid - In - Glass thermometers ( <i>first revision</i> )

## 3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 2627, in addition to the following, shall apply.

### 3.1 Schedule Mark

The number corresponding to the serially arranged thermometers in col 1 of Table 2.

## 4 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 *Conference generale des poids et mesures*, and in accordance with the International System of Units (SI).

## 5 IMMERSION

The thermometer shall be adjusted for use at total immersion, for example, the reading shall be correct when the thermometer is so immersed that the top of the liquid column is in the same plane as the surface of the medium, the temperature of which is required to be measured.

## 6 GLASS

**6.1** The thermometers shall be made of suitable thermometric glass (*see* IS 4610) so selected and processed that the finished thermometers show the following characteristics.

**6.2** 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.

**6.3** The bulb glass shall be stabilized by a suitable heat treatment to ensure that the accuracy requirements of **11.2** and **11.4** are met;

**6.4** The legibility of the reading shall not be impaired by devitrification or clouding.

**6.5** The image of the meniscus shall be distorted as little as possible by defects or impurities in the glass.

### 7 Thermometric Liquids

**7.1** The thermometric liquid shall be entirely free from contamination particularly of solid particles or of any liquid which produces a variation of volume with time.

**7.2** Recommended thermometric liquids and the approximate temperature ranges covered by them are given in table 1.

**TABLE 1 TEMPERATURE RANGES FOR VARIOUS THERMOMETRIC LIQUIDS**  
(Clause 7.2)

SI No.	Thermometric Liquid	Approximate Temperature Range, °C
(1)	(2)	(3)
i.	Mercury	-38 to +600
ii.	Mercury-thallium alloy [8.5 percent (m/m) of thallium]	-55 to +600
iii.	Alcohol	-80 to +50
iv.	Toluene (IS 537).	-90 to +50
v.	Technical pentane	-200 to +30
vi.	Kerosene Oil	-20 to +150

**7.3** The organic liquid used as the liquid filling shall, wherever possible, be coloured by means of light-fast dye which does not stain the glass. Alcohol shall comply in all respects with the provisions of Special Grade of IS 321 subject to the following modifications:

- a) *Aldehydes and ketones* — Alcohol shall not contain more than 0.02 percent (m/m) of aldehydes and ketones, calculated as acetaldehyde (CH<sub>3</sub>CHO); and
- b) *Amines* — Alcohol shall give no indication of the presence of amines when tested by adding to 10 ml of alcohol, 10 ml of distilled water followed by 2 drops of a saturated solution of *p*-nitrophenol in water. Not more than 0.05 ml (1 drop) of 0.1 N sulphuric acid shall be required to discharge any yellow colour produced.

## 8 GAS FILLING

Thermometers having an upper nominal limit above 100 °C shall be filled with a dry, inert gas. The pressure of the gas shall be high enough to raise the boiling point of the liquid filling sufficiently to minimize vaporization,

## 9 CONSTRUCTION

### 9.1 Patterns

The thermometers shall be of 3 patterns, namely, Patterns A, B and C. The thermometers shall be straight and their external cross-section approximately circular (*see* Fig. 1).

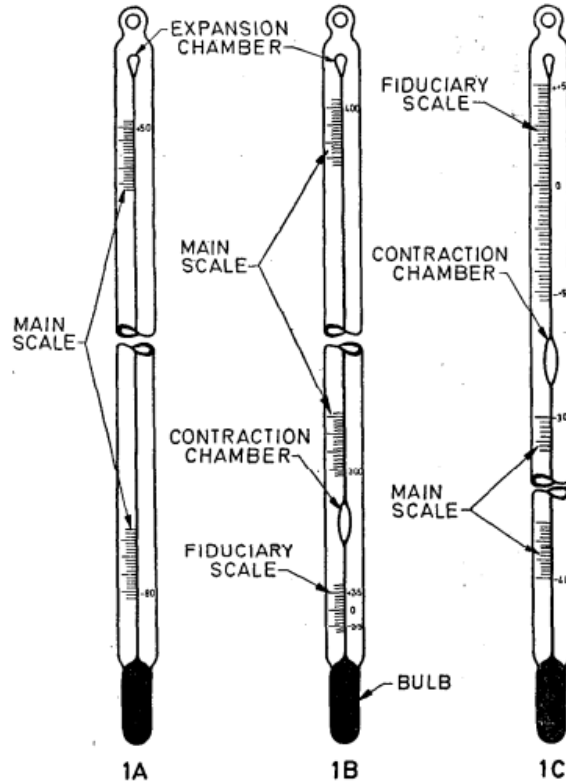


FIG. 1 PATTERNS OF REFERENCE THERMOMETERS

**TABLE 2 SCALES AND DIMENSIONS OF LIQUID-IN-GLASS SOLID-STEM REFERENCE THERMOMETERS**

(Clause 3.1, 9.7, 10.1.1 and 11.2)

i)	Diameter of stem	5.5 mm to 8 mm
ii)	Bulb length	15 mm to 40 mm
iii)	Diameter of bulb	Not more than that of stem

SCHEDULE MARK	MAIN SCALE	SCALE INTERVAL	SCALE ERROR (Max)	LONGER LINES AT EACH	OVERALL LENGTH (Max)	LENGTH OF MAIN SCALE (Min)	AUXILIARY SCALE	DISTANCE FROM THE BOTTOM OF THE BULB TO THE START OF THE MAIN SCALE, (Min)	PATTERN (See FIG. 1)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	°C	°C	°C	°C	mm	mm	m °C	mm	
1	-40 to -30	0.05	0.2	0.1	500	280	-0.5 to +0.5	85	C
2	-30 to -20	0.05	0.2	0.1	500	280	-0.5 to +0.5	85	C
3	-20 to -10	0.05	0.2	0.1	500	280	-0.5 to +0.5	85	C
4	-10 to 0	0.05	0.2	0.1	500	280	—	85	A
5	0 to 10	0.02	0.1	0.1	500	280	—	85	A

6	10 to 20	0.02	0.1	0.1	500	280	-0.5 to + 0.5	85	B
7	20 to 30	0.02	0.1	0.1	500	280	-0.5 to + 0.5	85	B
8	30 to 40	0.02	0.1	0.1	500	280	-0.5 to + 0.5	85	B
9	40 to 50	0.02	0.1	0.1	500	280	-0.5 to + 0.5	85	B
10	50 to 60	0.02	0.1	0.1	500	280	-0.5 to + 0.5	85	B
11	60 to 70	0.02	0.2	0.1	500	280	-0.5 to + 0.5	85	B
12	70 to 80	0.02	0.2	0.1	500	280	-0.5 to + 0.5	85	B
13	80 to 90	0.02	0.2	0.1	500	280	-0.5 to + 0.5	85	B
14	90 to 100	0.02	0.2	0.1	500	280	-0.5 to + 0.5	85	B
15	100 to 110	0.05	0.2	0.1	350	120	-0.5 to + 0.5	85	B
16	110 to 120	0.05	0.2	0.1	350	120	-0.5 to + 0.5	85	B
17	120 to 130	0.05	0.2	0.1	350	120	-0.5 to + 0.5	85	B
18	130 to 140	0.05	0.2	0.1	350	120	-0.5 to + 0.5	85	B
19	140 to 150	0.05	0.2	0.1	350	120	-0.5 to + 0.5	85	B
20	-40 to +10	0.1	0.2	0.5	450	280	—	85	A
21	0 to 50	0.1	0.2	0.5	450	280	—	85	A
22	50 to 100	0.1	0.3	0.5	450	280	-0.5 to + 0.5	85	B
23	100 to 150	0.1	0.4	0.5	450	280	-0.5 to + 0.5	85	B
24	150 to 200	0.1	0.4	0.5	450	280	-0.5 to + 0.5	85	B
25	200 to 250	0.1	0.5	0.5	450	280	-0.5 to + 0.5	85	B
26	250 to 300	0.1	0.5	0.2	450	280	-0.5 to + 0.5	85	B
27	-80 to +50	0.5	1.0	1.0	400	210	—	85	A
28	300 to 400	0.5	2.0	1.0	300	120	-0.5 to + 0.5	85	B
29	400 to 500	0.5	2.5	1.0	300	120	-0.5 to + 0.5	85	B

## 9.2 Top Finish

The top of the thermometer should preferably be finished with a plain top, button top or plastic or rubber cap/ring, the diameter of which shall not exceed that of the stem. Alternatively, a plain or button finish may be provided, and this may be preferred for thermometers having upper limit of the main scale above 300 °C.

## 9.3 Capillary Tube

**9.3.1** The-inside of the capillary tube shall be smooth.

**9.3.2** The cross-sectional area of the bore shall not show variations greater than 10 percent from the average and the bore shall be wide enough to ensure that jumping of the meniscus does not exceed one-fifth of the graduation interval.

**9.3.3** If the capillary tube incorporates an enamel backing, it shall be so positioned that it lies behind the liquid column when the latter is viewed in alignment with the right-hand ends of the shortest scale lines and also when viewed in alignment with the left-hand ends of all of the scale line.

## 9.4 Expansion Volume

**9.4.1** An expansion volume shall be provided at the top of the capillary tube.

NOTE — Overheating is liable to change the zero point of a thermometer and a redetermination will be necessary if it occurs.

**9.4.2** The volume above the scale shall be at least equivalent to that occupied by an interval of 80 °C of the scale.

**9.4.3** This volume should preferably consist of an expansion chamber, and this chamber shall be pear-shaped with the hemisphere at the top.

**9.4.4** For thermometers having upper limit of the main scale below 50 °C, the lower end of the expansion chamber shall be so elongated as to avoid the risk of a break in the mercury column during storage at ambient temperature.

### **9.5 Contraction Chamber**

Thermometers having a lower- limit of the main scale above 0 °C or upper limit of the main scale below 0 °C shall be provided with a contraction chamber to allow for the inclusion of an auxiliary scale (*see* Fig. 1 Patterns B and C). The contraction chamber shall be as elongated and narrow as possible to avoid a break in the mercury column at ambient temperature.

### **9.6 Position of Chambers**

No enlargement of the bore shall be so located as to produce any variation greater than that permitted in clause **9.3** in the cross-section of the capillary tube in the scale portion. The distance from the top of the contraction chamber to the first scale line of the scale immediately above it shall be not less than 15 mm, except that for thermometers having lower limit of the main scale above 150 °C, this distance shall be not less than 25 mm.

### **9.7 Dimensions**

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

## **10 GRADUATION AND FIGURING**

### **10.1 Graduations**

**10.1.1** The scale ranges and scale intervals of the thermometers shall be as given in Table 2.

**10.1.2** The scale lines shall be clearly and durably marked. They shall be equally spaced and shall be of uniform thickness which shall not exceed 0.12 mm. The lines shall be at right angles to the axis of the thermometer.

**10.1.3** 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 so viewed that the right-hand ends of the shortest scale lines align with the left-hand side of the bore, the medium and longer lines referred to shall extend across the bore towards the right.

**10.1.4** The length of the short scale lines shall be approximately 1 mm. The medium and long lines shall be suitably extended as prescribed in clause **9.1.1** of IS 8787.

### **10.2 Sequence of Graduations**

#### **10.2.1 General**

The arrangement of the scale lines shall be as follows.

- a) On thermometers where the smallest scale division is 0.1 °C:
  - i. every tenth scale line shall be a long line;
  - ii. there shall be a medium line midway between two consecutive long lines;
  - iii. there shall be four short line; equally spaced between consecutive medium and long lines (*see* Fig. 2).
- b) On thermometers where the smallest scale division is 0.02 °C:
  - a) every fifth scale line shall be a long line;
  - a) there shall be four short lines equally spaced between two consecutive long lines (*see* Fig. 2).

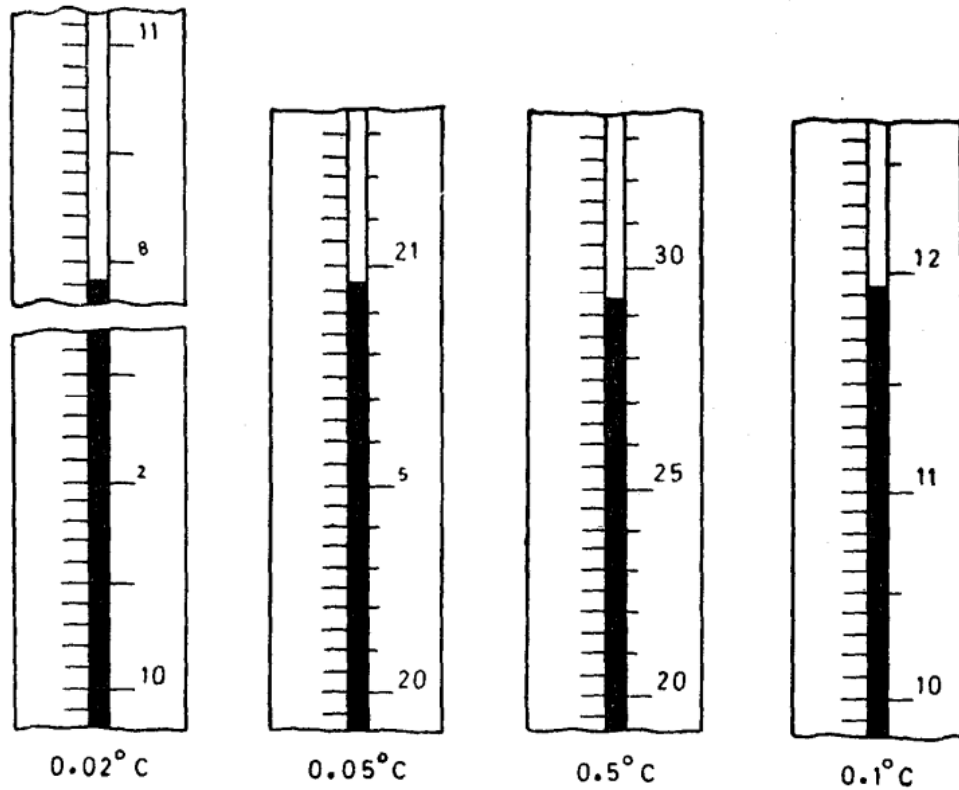


FIG. 2 GRADUATION AND FIGURING OF THERMOMETERS

10.2.4 On thermometers where the smallest scale division is 0.05 °C or 0.5 °C:

- a) every tenth scale line shall be a long line;
- b) there shall be four medium lines equally spaced between two consecutive long lines;
- c) there shall be one short line between two consecutive medium lines or between consecutive medium and long lines (*see* Fig. 2).

**10.3 Figuring**

10.3.1 The figures shall be placed slightly to the left or to the right of the line to which they refer, as preferred, in such a way that an extension of the line would bisect them or pass immediately under them, The figures may be placed parallel to, or at right angles, to the axis of the thermometer, as preferred.

10.3.2 Every tenth scale line shall be shall be figured and the series of figures shall be in accordance with the Smallest Scale Division as given in table 3.

**TABLE 3 SERIES OF FIGURES**

(Clause 10.3.2)

Sl No.	Smallest Scale Division, °C	Series of Figures, °C
(1)	(2)	(3)
i.	0.1	1, 2, 3, ....., etc.
ii.	0.02	0.2, 0.4, 0.6, ....., etc.
iii.	0.05	0.5, 1.0, 1.5, ....., etc.
iv.	0.5	5, 10, 15, ....., etc.

**10.3.3** The auxiliary scale shall be figured at 0 °C. Scale lines at 0 °C or 10 °C or 100 °C may be emphasized (for example, by full figuring if either the first or first and second digits are omitted at intermediate scale lines).

**10.3.4** The pigment filling shall remain in the scale lines, figures and inscriptions under normal conditions of use and under such other special conditions as may be specified between the purchaser and the vendor or manufacturer.

**10.3.5** Each end of the scale shall be extended by a minimum of five divisions beyond the nominal limits of the scale.

**10.3.6** All negative numbers may be indicated by minus signs, for example, -5 or 5 as preferred, so placed that they are not liable to be confused with the scale line, or other marking.

## 11 ACCURACY

**11.1** When tested in accordance with the methods prescribed in IS 6274, the scale and interval errors shall not exceed the limits prescribed in clause **11.2** and **11.3**.

### 11.2 Scale Error

The maximum permissible scale error shall not be more than the limit prescribed in col 4 of Table 2, when the thermometer is in a vertical position and at the prevailing atmospheric pressure.

### 11.3 Interval Error

The absolute value of the algebraic difference between the errors at any two points, which are not more than 50 divisions apart, shall not be greater than one scale division.

### 11.4 Change in Zero

When a thermometer is maintained over a period of 24 h at the highest temperature of the scale, the change in the zero point, determined by the method described in Annex A, shall not exceed one scale division, and the scale error shall remain within the limit prescribed in col 4 of Table 2.

## 12 MARKING AND PACKING

### 12.1 Packing

Each thermometer shall be packed suitably in protective cases to avoid breakage in transit.

### 12.2 Marking

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

- a) temperature scale indication: the official symbol '°C', or an abbreviation of the name Celsius (for example, '°C');
- b) gas filling, if any, for example, 'nitrogen filled', 'vacuous', or a suitable abbreviation;
- c) manufacturer's identification or serial number (where required);
- d) vendor's and/or maker's name or recognized trade-mark; and
- e) Schedule mark, for example, 7 — IS 4825 at the back of the thermometer.

#### 12.2.2 *BIS Certification Marking*

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act, 2016* and the Rules and Regulations framed thereunder, and the products may be marked with the standard mark.

## 13 SAMPLING

### 13.1 Lot

**13.1.1** All thermometers of the same type in a single consignment and produced under similar conditions of manufacture shall constitute a lot.



**13.1.2** Thermometers constituting the sample shall be drawn from each lot separately for deciding the conformity of the lot to the requirements of the specification.

### 13.2 Scale of Sampling

Number of thermometers to be selected at random from the lot shall depend on the lot size and shall be in accordance with col 3 of Table 5. In order to ensure randomness of selection, procedures given in IS 4905 may be followed.

**TABLE 5 SCALE OF SAMPLING**  
(Clause 13.2, 13.3.2)

<b>Sl No.</b>	<b>No. of thermometers in the lot</b>	<b>Sample size</b>	<b>Rejection Number</b>
(1)	(2)	(3)	(4)
i.	Less than 150	20	1
ii.	151 to 280	32	2
iii.	281 to 500	50	3
iv.	501 to 1 200	80	5
v.	1 201 and above	125	7

### 13.3 Criteria for conformity

**13.3.1** For deciding the conformity of the lot to the requirements of this specification, the test results of each characteristic shall meet the corresponding requirements specified in the relevant clauses.

**13.3.2** The lot shall be declared as conforming to the requirements of the specification, if the number of defectives is equal or less than the number given in col 4 of Table 5.

**ANNEX A**  
(*Clause 11.4*)

**METHOD OF DETERMINING CHANGE IN ZERO**

**A-1 PROCEDURE**

Heat the thermometer, immersed in a test bath, to a temperature equal to its highest reading and keep it at this temperature for 5 min. Allow the thermometer to cool either naturally in still air or slowly in the test bath (at a reproducible rate) to 20 °C above ambient temperature or to 50 °C, whichever is the lower, and then determine the zero. If natural cooling is used, the zero should be determined within 1 h. Heat the thermometer again to a temperature equal to its highest reading, keep it at this temperature for 24 h, allow the thermometer to cool to one of the two temperatures referred to above, at the same rate as at the start of the test, and redetermine the zero under the same conditions as before.