

BUREAU OF INDIAN STANDARDS

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Draft Indian Standard

**GENERAL METEOROLOGICAL LIQUID IN-GLASS
THERMOMETERS — SPECIFICATION**
(Third Revision)

भारतीय मानक मसौदा

सामान्य मौसम वैज्ञानिक काँच-द्रव वाला थर्मामीटर — विशिष्टि

(तीसरा पुनरीक्षण)

ICS 17.200.20

Glass, Glassware & Laboratoryware Sectional Committee, CHD 10

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FOREWORD

(Formal clause to be added later)

For general meteorological work, measurements of temperature and humidity of air are made with a set of four liquid-in-glass thermometers, one maximum, one minimum and two ordinary, the bulb of one of which is covered by a layer of thin wet cloth. They are provided with wooden mounts for extra strength and robustness (*see* Fig. 1) and exposed in louvered thermometer screens.

This standard is based on existing India Meteorological Department Specifications and has been prepared in the interests of standardization of thermometers used for general meteorological work in the country and of accuracy in the measurement of air temperature and humidity.

In the formulation of this standard, due consideration has been given to the requirements laid down by the World Meteorological Organization, Geneva.

The temperature ranges specified make the thermometers suitable for use anywhere in India.

This standard was first published in 1970. In the first revision in 1983, the quantity of raw materials of construction such as glass, thermometric liquid, etc., was revised along with the requirements of dimensions and accuracy. And in the second revision in 1992, the overall dimensions of the thermometers were changed. The plastic scale was specified.

In this third revision, Kerosene oil as a thermometric liquid has been added. A sampling plan for lot testing has been prescribed and several editorial changes such as the inclusion of the Reference clause, Hindi Title, ICS no, BIS certification marking clause, etc. have also been incorporated.

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IS 5681: 20XX

December 2023

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

GENERAL METEOROLOGICAL THERMOMETERS, LIQUID-IN-GLASS — SPECIFICATION

(Third Revision)

1 SCOPE

This standard specifies requirements for maximum, minimum and ordinary (wet and dry bulb) meteorological thermometers provided with suitable mounts for exposure in a louvered thermometer screen.

2 REFERENCES

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>Title</i>
IS 321 : 1964	Specification for absolute alcohol (<i>first revision</i>)
IS 347 : 2023	Varnish shellac for general purposes — Specification (<i>second revision</i>)
IS 451 : 1999	Technical supply conditions for wood screws (<i>third revision</i>)
IS 2627 : 1979	Glossary of terms relating to liquid-in-glass thermometers (<i>first revision</i>)
IS 4610 : 1968	Glass tubes for general purpose for general purpose and reference thermometers
IS 6274 : 1971	Method of calibrating liquid-in-glass thermometers

3 TERMINOLOGY

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

4 TYPES

The thermometers shall be of the liquid-in-glass, solid-stem type with enamel back as follows:

- Maximum thermometer — Mercury-in-glass, having a range from -35 °C to + 55 °C;
- Minimum thermometer — Alcohol-in-glass, having a range from - 40 °C to + 50 °C; and
- Ordinary thermometer (wet and dry bulb) — Mercury-in-glass, having a range from - 35 °C to + 55 °C

5 REQUIREMENTS

5.1 Immersion

The thermometers shall be graduated for total immersion.

5.2 Glass

The stem and bulb tubing of the thermometers shall conform to IS 4610.

5.2.1 The thermometer bulb shall be made of suitable thermometer glass. The glass or glasses comprising the thermometer shall be selected and processed so that the finished thermometer shows the following characteristics:

- 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 laid down in 5.8 are met.
- 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.

5.3 Thermometric Liquid

5.3.1 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.

5.3.2 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 5.3.2)

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

5.3.3 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 (CH₃CHO); 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.

5.4 Construction

5.4.1 Shape

The thermometers shall be straight, having a substantially spherical bulb with its centre approximately in alignment with the axis of the stem.

5.4.2 Finish of Top End

The top of the mounted thermometers shall end in a bent nib to permit their securing in position in a hole in the wooden mount with plaster of paris.

5.4.3 Capillary Tube

The inside of the capillary tube shall be smooth. The cross sectional area of the bore shall not show variations greater than 10 percent of the average value except at the bulb and the expansion chamber, if provided.

5.4.3.1 Maximum thermometer

In the maximum thermometer a constriction or plug shall be placed in the bore below the lowest graduation so that as the temperature falls, the mercury column is not drawn back past the constriction when the thermometer is inclined with the stem, sloping upwards at an angle of 10° or less to the horizontal. The mercury shall shake through the construction without undue effort (the mercury column should retreat at least 1 °C with a not too vigorous shake) when the thermometer is being reset, but the registering column shall not pass through so easily that the thermometer acts as an ordinary thermometer when placed in an approximately horizontal position. 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 is subjected to vibration (such as might be caused by opening the door of the screen) in the normal position of use, that is, inclined at an angle of about 2° to the horizontal with the bulb at the lower end.

During testing when the thermometer is held vertically with the bulb end down, the mercury column should not descend to the bulb unless it is swung briskly downwards holding the thermometer by the end remote from the bulb or by whirling it.

5.4.3.2 Minimum thermometer

In the minimum thermometer, an index of dark shall be provided in the bore. The length of this index shall be of about 20 mm. It shall be so light that the contracting spirit column will always draw it back, when the thermometer stem is approximately horizontal. 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.

5.4.4 Safety Chamber

The thermometer shall be so constructed as to withstand without damage temperature of at least 65 °C. A small elongated safety chamber with a rounded end and without re-entrant shoulders shall be provided in the ordinary and minimum thermometers. No safety chamber or enlargement of the bore shall be permitted in the maximum thermometer.

5.5 Graduation

5.5.1 The graduation lines shall be clearly etched on the stem at each half degree and shall be of uniform thickness not exceeding 0.15 mm.

5.5.2 The graduation lines shall be equally spaced and at right angles to the axis of the thermometer.

5.5.3 The left hand ends of the graduation lines shall lie on an imaginary vertical line when the thermometer is viewed from the front and in a vertical position.

5.6 Figuring

5.6.1 The thermometers shall be figured at an interval of five degrees, in bold figures of uniform thickness (*see* Fig. 2, 3, 4 and 5).

5.6.2 The figures shall be upright when the thermometer is viewed from the front, with the thermometer vertical for ordinary thermometers with the thermometer in a horizontal position with the bulb to the left for the maximum and minimum thermometers.

5.6.3 The figures shall be placed symmetrically below the line or right of the line to which they refer as if that the line was extended shall intersect the figure.

5.6.4 All the graduation lines and figures shall be filled with black pigment.

5.7 Dimensions

The dimensions of thermometers shall be as given in Table 2 read with Fig. 2, 3, 4 and 5.

TABLE 2 DIMENSIONS FOR GENERAL METEOROLOGICAL THERMOMETERS, LIQUID-IN-GLASS

(*Clause 5.7*)

SI No.	Particulars	Types of Thermometer		
		Maximum	Minimum	Ordinary
(1)	(2)	(3)	(4)	(5)
		mm	mm	mm
i)	Overall length, <i>Max</i>	325	325	300
ii)	Stem diameter	5.5 to 6.0	5.5 to 6.0	5.5 to 6.0
iii)	Length of parallel portion of bore above the scale, <i>Min</i>	10	10	10
iv)	Bulb diameter	10.0 ^{+1.5} _{-1.0}	12 ± 2	10.0 ^{+1.5} _{-1.0}
v)	Distance from bottom of the bulb to the lowest nominal temperature	65 to 75	65 to 75	50 to 60
vi)	Scale length for 180 graduations, <i>Min</i>	190	190	190

5.8 Ranges and Accuracy

The ranges and accuracy of thermometers shall be as given in Table 3.

5.9 Mount

The mounts shall be made of wood as shown in Fig. 2, 3, 4 and 5. The scale shall be fixed on the wooden mount and the thermometer fixed to the scale and mount with either staples or a crosspiece. All brass fittings in the mounts of the three types of thermometers shall be painted with three coats of cellulose, matt, black paint.

5.9.1 Scales

5.9.1.1 Dimensions

The scale shall be made of unbreakable and rigid milk white plastic and shall have the dimensions given in Table 4.

5.9.1.2 Graduation and figuring

The scales shall be graduated to match the thermometer as shown in Fig. 2, 3, 4 and 5. The scales may be permanently printed or engraved.

5.9.1.3 The graduation marks shall be about 5 mm long.

5.9.1.4 The figures shall be bold and about 4 mm high. Temperatures below 0 °C shall be indicated by a minus sign to the left immediately before the corresponding figure.

5.9.1.5 The figures shall be upright when the thermometer is viewed from the front, in a vertical position for the ordinary thermometers, and horizontal with the bulb to the left, for the maximum and minimum thermometers.

5.9.1.6 The figures shall be so placed that they would be intersected by the line to which they refer, if it were extended.

5.9.2 Mount for Maximum and Minimum Thermometers

5.9.2.1 The scale shall be embedded wholly on a wooden mount 300 × 60 × 15 mm, so that the upper surface of the mount and scale are at the same level.

**TABLE 3 RANGES AND ACCURACY FOR GENERAL METEOROLOGICAL THERMOMETERS,
LIQUID-IN-GLASS**

(Clause 5.8)

Sl No.	Particulars	Types of Thermometer		
		Maximum	Minimum	Ordinary
(1)	(2)	(3)	(4)	(5)
		mm	mm	mm
i)	Range (main scale), °C	- 35 to + 55	- 40 to + 50	- 35 to + 55
ii)	Graduation interval, degree Celsius	0.5	0.5	0.5
iii)	Scale error, degree Celsius, <i>Max</i>			
	a) Below — 18 °C	± 0.4	± 0.3	—
	b) Above — 18 °C	± 0.2	± 0.3	—
	c) Below 0 °C	—	—	- 0.3 to + 0.2
	d) Above 0 °C	—	—	- 0.2 to + 0.1
iv)	Interval error, degree Celsius/10 degrees Celsius	± 0.2	± 0.2	± 0.2

NOTES

1 The scale tolerances have been arranged to permit greater negative errors than positive errors in view of the tendency of the zero of mercury-in-glass thermometers to rise slowly with time.

2 The maximum error in an interval is expressed in the form. Interval error/intervals, the interval error being the algebraic difference between the errors at the opposite ends of the intervals, for example, 0.2/10 means that the change of error in an interval of 10 degrees Celsius shall not exceed 0.2 degree Celsius.

TABLE 4 DIMENSIONS OF THE PLASTIC SCALE

(Clause 5.9.1.1)

Sl No.	Type of Thermometer	Length	Width	Thickness
(1)	(2)	(3)	(4)	(5)
		mm	mm	mm
i)	Maximum	265	40	3
ii)	Minimum	265	40	3
iii)	Ordinary	275	35	3

NOTE — Tolerances on the dimensions of scale shall be in accordance with the general engineering practice.

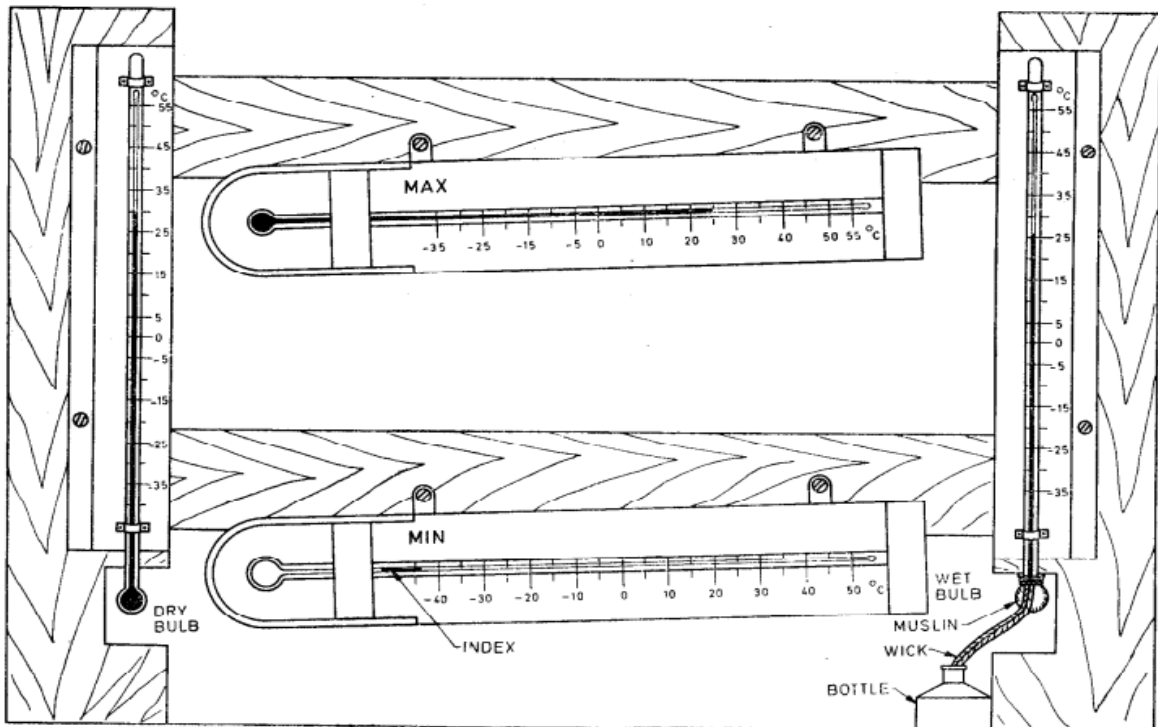
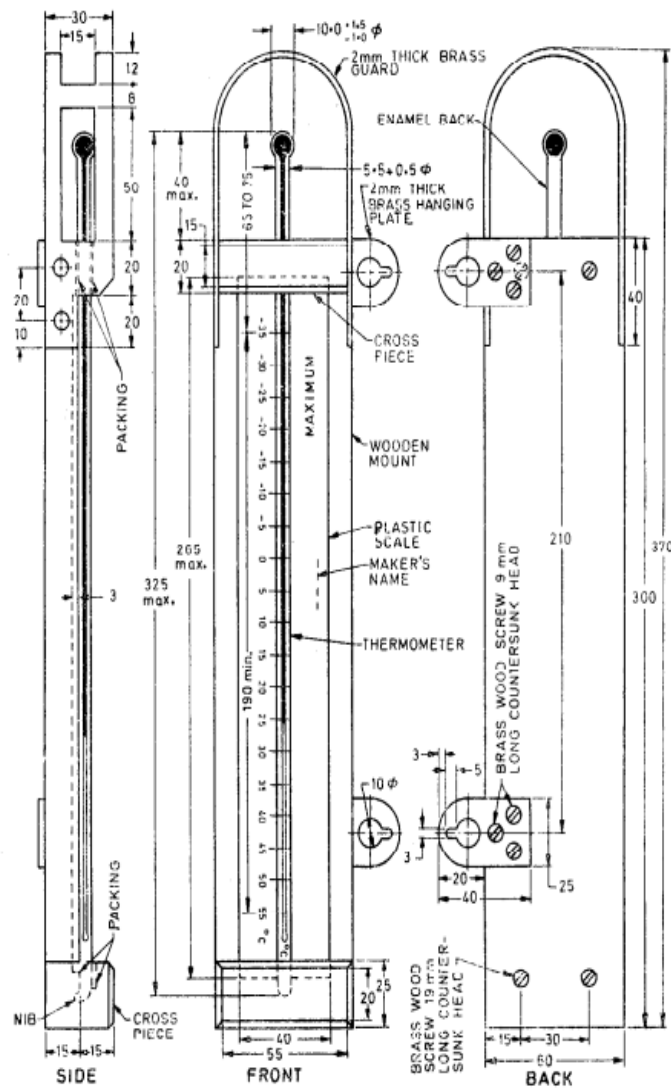
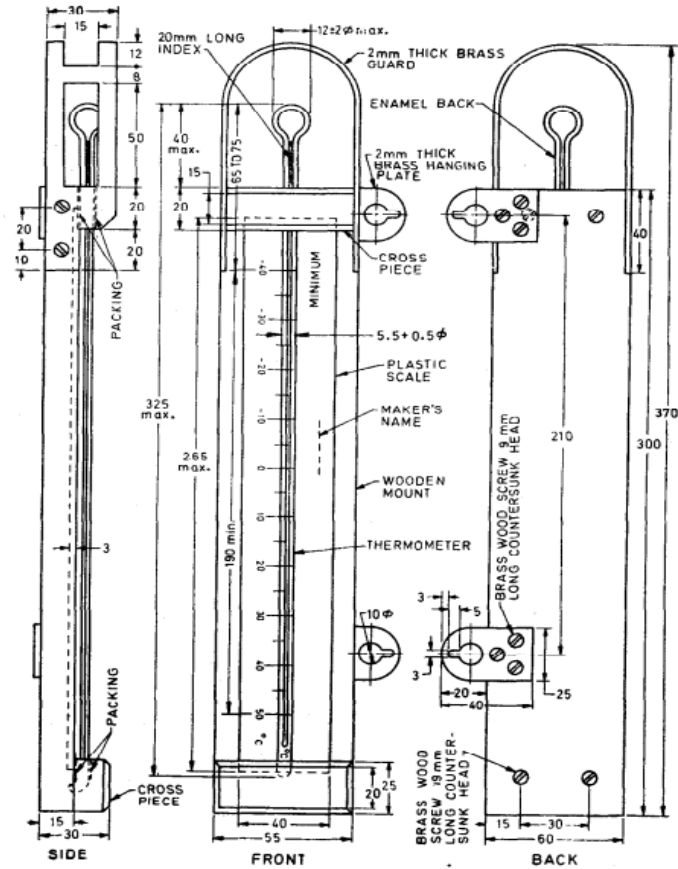


FIG. 1 SUITABLE ARRANGEMENT FOR MOUNTED THERMOMETERS IN SCREEN

5.9.2.2 Both the thermometer and the scale shall be secured to the mount by means of two crosspieces of teak wood, each screwed on from the back as shown in Fig. 2 and 3 with countersunk head screws 20 mm long (*see* IS 451). To ensure that the thermometer stem is firmly gripped, a felt or cork packing may be used, but the stem of the thermometer shall not thereby be raised above the general level of the mount.



All dimensions in millimetres.
 FIG. 2 MAXIMUM THERMOMETER WITH MOUNT



All dimensions in millimetres.

FIG. 3 MINIMUM THERMOMETER WITH MOUNT

5.9.2.3 The mount and cross-pieces shall be made of straight grained and well-seasoned teak wood, polished and finished with a protective coat of clear varnish.

5.9.2.4 When mounted, the bulb shall not project more than 40 mm beyond the edge of the mount and the end of the bore of the capillary tube shall be visible.

5.9.2.5 The hanging plates shall be of hard brass sheet 2 mm thick and accurately located on the mount so that the distance between the two centres is 210 mm. The left-hand plate shall be flush with the end of mount and secured with 10 mm long wood screws with countersunk head.

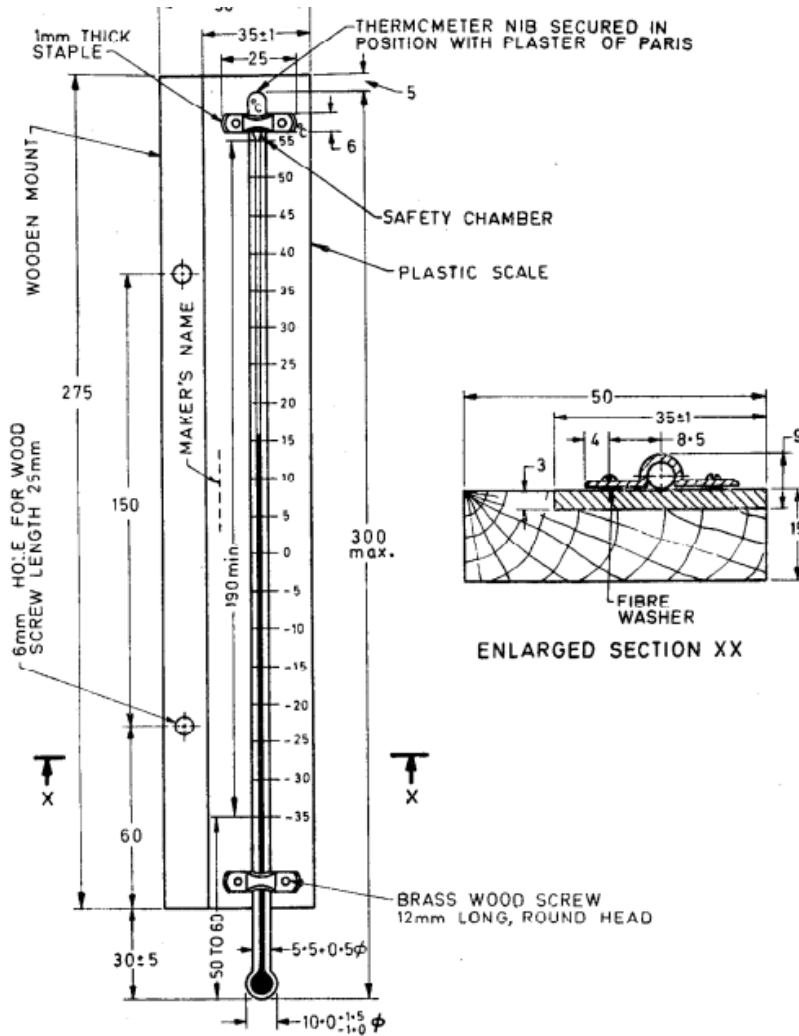
5.9.2.6 A guard made of hard brass sheet 2 mm thick and suitably lacquered (*see* IS 347) shall be provided and let into the mount flush with the sides and attached on either side with 10 mm long brass screws with countersunk head (*see* IS 451).

5.9.3 Mount for Ordinary Thermometers

5.9.3.1 The ordinary thermometers shall be fixed to the scale by two brass staples, shaped and positioned as shown in Fig. 4 and 5. The staples shall not cover any of the graduation marks and the centre of the lower staple shall not be less than 5 mm above the lower edge of the mount. Round headed brass wood screws 12 mm long (*see* IS 451) with fibre washers shall be used to secure the staples to the mount.

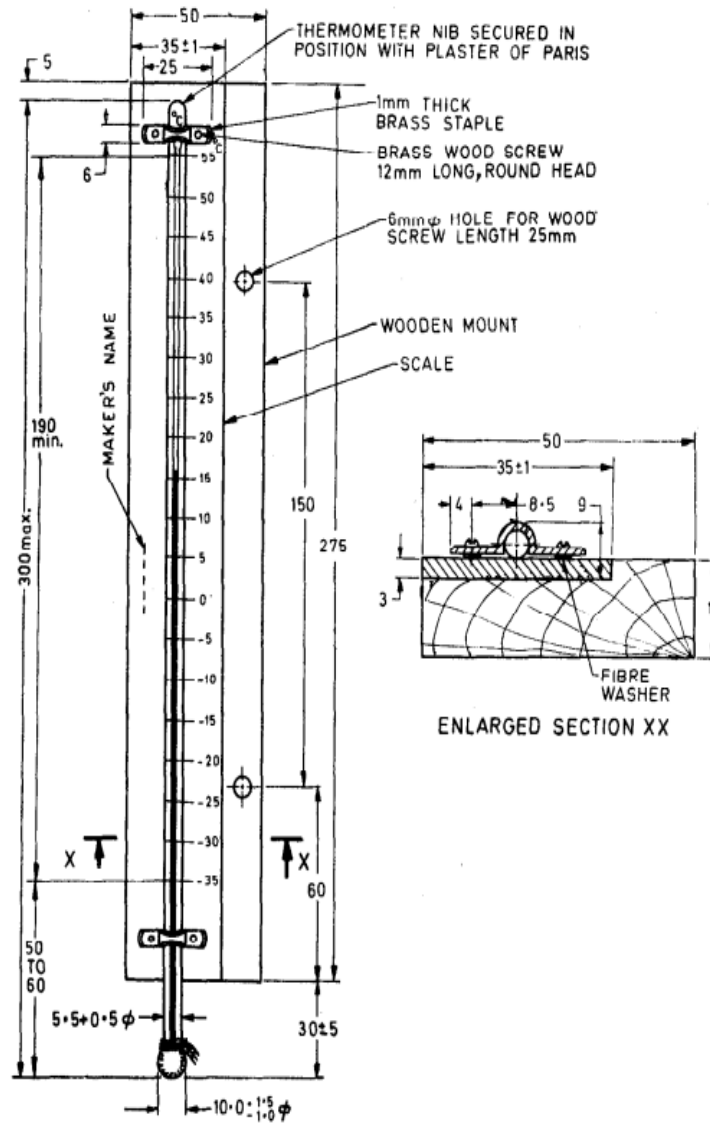
5.9.3.2 When fitted on the scale, the height of the highest point of the thermometer tube above the bottom of the scale shall not be more than 9 mm. The distance from the bottom of the scale to the bottom of the bulb shall not exceed 35 mm or be less than 25 mm.

5.9.3.3 The scale shall be embedded in a piece of seasoned wood 275 mm × 50 mm × 15 mm so that the upper surface of the mount and scale are at the same level. For the dry bulb thermometer the scale with thermometer shall be fixed to the right side of the mount and for the wet bulb to the left side of the mount (*see* Fig. 4 and 5). The top, bottom and vertical edges of the scale shall be flush with those of the mount.



All dimensions in millimetres.

FIG. 4 ORDINARY (DRY BULB) THERMOMETER WITH MOUNT



All dimensions in millimetres.

FIG. 5 ORDINARY (WET BULB) THERMOMETER WITH MOUNT

5.9.3.4 Two holes 6 mm in diameter for receiving 25 mm long wood screws shall be provided, with which the mount can be fixed in the louvered thermometer screen.

5.10 Wick and Reservoir

These shall be agreed to between the purchaser and the supplier.

6 MARKING

6.1 Each thermometer shall be permanently and legibly marked on both the thermometer and scale with the following:

- Letter °C to indicate that the Celsius scale is used,
- An identification number and year of manufacture,
- The type of the thermometer, and
- Indication of the source of manufacture.

6.2 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.

7 PACKING

Each mounted maximum and minimum thermometer and dry and wet bulb thermometer with its mount may be supplied in a wooden case with a hinged lead of inner dimensions 380 mm × 90 mm × 40 mm (for *Max* and *Min*) and 320 mm × 60 mm × 30 mm (for dry bulb and wet bulb thermometer). The thermometer with its mount shall be fixed to the box with two screws. Brass screws shall be used throughout. Alternatively, the packing may be as agreed to between the purchaser and the supplier.

8 SAMPLING

8.1 Lot

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

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

8.2 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 8.2, 8.3.2)

SI No.	No. of thermometers in the lot	Sample size	Rejection Number
(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

8.3 Criteria for conformity

8.3.1 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.

8.3.2 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.