

IS : 6592 - 1972

Indian Standard
SPECIFICATION FOR
SOIL THERMOMETERS

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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 1

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Gr 5

Indian Standard

SPECIFICATION FOR SOIL THERMOMETERS

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Indian Standard
SPECIFICATION FOR
SOIL THERMOMETERS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 20 June 1972, after the draft finalized by the Laboratory Glassware and Related Apparatus Sectional Committee had been approved by the Chemical Division Council.

0.2 The measurement of soil temperature is of great importance in meteorological and agricultural studies, and is made with the thermometer bulbs exposed on the surface of the soil and at various depths up to 100 cm. The standard depths for soil temperature measurements are 5, 10, 20, 50 and 100 cm. Soil thermometers at depths of 5, 10 and 20 cm are part of the standard equipment at agricultural observatories in India. Bent-stem mercury-in-glass thermometers clamped to special triangular stands bent at 60° so that they can support the thermometers at the correct inclination to the ground, are used for the measurement of soil temperatures at shallow depths, while at greater depths lagged thermometers suspended in iron tubes sunk into the soil to the required depth are used. Details of these are given in Fig. 10 and 11.

0.3 As the temperature of the soil varies much more slowly than the air temperature, its mean value can be obtained with a higher degree of accuracy. In the surface layers, however, variations of appreciable magnitude may occur within small horizontal areas due to differences in the soil covering, but at lower depths the temperatures over a horizontal area are generally more uniform. At depths up to 50 cm the temperature can be read to an accuracy of 0.1°C and the corrections of the thermometers should therefore be known to that degree of precision. At greater depths, the temperature variations are so slow that measurement to even greater accuracies is desirable.

0.4 In the formulation of this standard assistance has been derived from the specifications for soil thermometers prepared by the India Meteorological Department, Government of India, for use of meteorological observatories in the country.

0.5 This standard contains clause 7.2 providing for agreement between the purchaser and the supplier.

0.6 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, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard prescribes the requirements for soil thermometers for use at the soil surface and at depths of 5, 10, 20, 50 and 100 cm below the surface.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS : 2627-1963† shall apply.

3. TYPES, IMMERSION AND RANGES

3.1 Types and Immersion — The thermometers for use at the soil surface and at depths of 5, 10 and 20 cm shall be of liquid-in-glass enclosed-scale or sheathed solid-stem type and shall be graduated for vertical partial immersion.

3.1.1 The thermometers for use at depths of 50 and 100 cm below the surface shall be of liquid-in-glass sheathed solid-stem type and shall be graduated for vertical total immersion.

3.2 Ranges — The thermometers for use at the soil surface and at depths of 5, 10 and 20 cm shall have a range from -20 to $+65^{\circ}\text{C}$ with the smallest scale divisions equivalent to 0.5°C .

3.2.1 The thermometers for use at depths of 50 and 100 cm below the surface shall have a range from -20 to $+50^{\circ}\text{C}$ with the smallest scale divisions equivalent to 0.5°C .

4. DESIGNATION

4.1 The thermometers shall be designated by the name, type and depth of use separated by a hyphen.

Example:

A soil thermometer of enclosed-scale type meant for use at the soil surface shall be designated as 'ST/ES-S'.

*Rules for rounding off numerical values (*revised*).

†Glossary of terms relating to liquid-in-glass thermometers.

5. REQUIREMENTS

5.1 Materials

5.1.1 Glass — The stem of the thermometers of enclosed-scale type shall be of suitable clear transparent glass free from occlusions, striae, stresses and visual defects, such as bubbles, knots, reflection failure and roughness of the bore. Bulb tubing shall conform to IS : 4610-1968*.

5.1.1.1 The tubes used for the sheathed solid-stem type thermometers shall have an enamelled back to outline the scale etched on its front face and conform to IS : 4610-1968*.

5.1.2 Thermometric Liquid — Recommended thermometric liquid is pure and dry mercury.

5.2 Construction

5.2.1 Thermometers for the Surface and for Depths of 5, 10 and 20 cm

5.2.1.1 Stem — The stem shall be straight and preferably lens-fronted in the graduated portion. The lens front shall magnify the mercury column in the bore to a width of at least 1 mm. It shall be bent near the bulb at an angle of 120°, the bend being in the form of a curve approximately 10 mm in radius.

5.2.1.2 No enlargement of bore shall be permissible in the graduated portion of the stem or within 10 mm from either end of the scale.

5.2.1.3 Bulb — The bulb shall be cylindrical and in alignment with the stem. The shape and finish of the bulb shall be such as not to entrap the thermometric liquid.

5.2.1.4 The top of the outer glass case shall be finished smooth and round.

5.2.1.5 Expansion chamber — The thermometers shall be so constructed as to withstand a temperature of 80°C without damage. An elongated or pear-shaped expansion chamber with a hemispherical top and without re-entrant shoulders shall be provided at the top end of the capillary in line with the capillary bore to enable the thermometers to withstand the above temperature.

5.2.2 Specific Requirements for Enclosed-Scale Type Thermometers

5.2.2.1 Pattern — The thermometers shall conform to the shapes prescribed in Fig. 1 to 4 (see P 10 to 13).

5.2.2.2 The capillary tube shall be enclosed in an outer case of stout clear glass tubing of approximately 20 mm diameter in the graduated portion and 10 mm in the lower ungraduated portion. It shall be supported inside the outer case by plugs of asbestos, cotton or similar material, inserted as shown in Fig. 1 to 4.

*Specification for glass tubes for general purpose and reference thermometers.

5.2.2.3 The opal glass scale shall be sliding fit in the outer case and be held in position between two pieces of cork so that there is no relative movement between the stem and the scale.

5.2.3 *Specific Requirements for Sheathed Solid-Stem Type Thermometers*

5.2.3.1 *Pattern* — The thermometers shall conform to the shapes prescribed in Fig. 5 to 8 (*see* P 14 to 17). The entire stem shall be enclosed in an outer sheath of stout clear glass tubing of approximately 20 mm diameter finished smooth and round at the top. The outer glass cover shall have a low heat capacity and, therefore, not be unduly bulky. At the same time it shall be sufficiently robust to withstand the normal risks of handling and transport.

5.2.3.2 The thermometer shall be supported inside the outer glass^s tubing by two pieces of cork, one at the top above the scale and the other below it. The cork piece at the top shall not conceal the expansion chamber.

5.2.3.3 The thermometers shall be suitably annealed before graduation.

5.2.4 *Thermometers for 50 and 100 cm Depths*

5.2.4.1 *Pattern* — The thermometers shall conform to the shape prescribed in Fig. 9 (*see* P 18). The stem shall be straight and the bulb spherical and in alignment with the stem.

5.2.4.2 No enlargement of the bore shall be permissible in the graduated portion of the stem or within 10 mm from either end of the scale.

5.2.4.3 The thermometer shall be mounted centrally in an outer glass case, at least 1.5 mm thick, as shown in Fig. 9. The upper end of the thermometer stem shall be fused to a piece of short glass tubing of approximately the same diameter as the stem. This glass tubing shall be securely fused to the end of the outer glass case and shall terminate in a bulb shape and extend about 25 mm above the joint.

5.2.4.4 A stout piece of rubber tubing about 65 mm long and approximately 25 mm external diameter shall be securely wound at one end round the upper part of the outer case and at the other end round a boxwood plug by means of suitable copper wire. The top of the bore of the thermometer tube shall be visible below the edge of the rubber tubing after assembly.

5.2.4.5 Two rubber rings each about 3 mm thick shall be provided to fit tightly round the outer glass case as shown in Fig. 9. A brass screw eye shall be screwed into the wooden plug at top for attaching the thermometer to a chain.

5.2.4.6 The lower end of the thermometer shall be embedded in a plug of pure paraffin wax to a height of about 38 mm from the bottom of the glass case.

5.2.4.7 The shape and finish of the bulb shall be such as not to entrap the thermometric liquid.

5.2.4.8 The thermometer shall be provided with an expansion chamber satisfying the requirements given in **5.2.1.5** to enable it to withstand a temperature of 65°C without damage.

5.2.4.9 The thermometer shall be suitably annealed before engraving.

5.3 Dimensions — The thermometers shall conform to the dimensions shown in Table 1 (*see* P 9) read with Fig. 1 to 9.

5.4 Immersion Line — The thermometers for use at the soil surface and at depths of 5, 10 and 20 cm shall be marked for immersion at 20, 60, 115 and 230 mm respectively from the top of the bulb.

5.5 Graduation and Figuring

5.5.1 The graduation lines and figures shall be clearly engraved on the opal glass scale or solid stem at each 0.5°C and shall be of uniform thickness not exceeding 0.15 mm. They shall be filled with black pigment.

5.5.2 The graduation lines shall be at right angles to the axis of the thermometer when the thermometer is viewed from the front in a vertical position.

5.5.3 The graduation lines in the enclosed-scale type thermometers shall be 8 and 12 mm long for 0.5°C and 1°C respectively. The graduation lines for 5°C and its multiples shall be as long as the full width of the scale. In the sheathed solid-stem type thermometers these shall be 1.5, 3 and 4 mm long respectively.

NOTE — The length of graduation line for 0°C mark shall be the same as that for 5°C and its multiples.

5.5.3.1 In the enclosed-scale type thermometers the graduation lines shall extend on the scale equally on either side of the axis.

5.5.3.2 In the sheathed solid-stem type thermometers, the left-hand ends of the graduation lines shall lie on an imaginary line parallel to the axis. No graduation line shall cross the bore.

5.5.4 Graduation lines indicating temperatures equivalent to 0°C, 5°C and its multiples shall be marked with bold figures of uniform thickness.

5.5.5 The figures shall be placed immediately above the extended lines to which they refer as shown in Fig. 1 to 9.

5.5.6 The number of divisions in 25 mm length shall not exceed 20.

5.6 Triangular Stand and Iron Tube — The triangular stand for thermometers shown in Fig. 1 to 8 shall be as shown in Fig. 10 (*see* P 19) and the iron tube for thermometer shown in Fig. 9 shall be as shown in Fig. 11 (*see* P 20).

6. ACCURACY

6.1 Scale Error — The maximum permissible scale error at any point shall be $\pm 0.2^{\circ}\text{C}$ below 0°C and $\pm 0.1^{\circ}\text{C}$ above 0°C .

6.2 Interval Error — The maximum change of error between two points separated by an interval of 10°C on the stem shall not exceed 0.1°C below 0°C and 0.05°C above 0°C .

7. MARKING AND PACKING

7.1 Marking — Each thermometer shall be marked legibly and permanently with the following information:

- a) The letter 'C' near the top of the scale;
- b) Maker's name or recognized trade-mark, if any, at the back of the scale or stem;
- c) Serial number and year of manufacture; and
- d) Designation.

7.1.1 The thermometers may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act, and the Rules and Regulations made thereunder. Presence of this mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard, under a well-defined system of inspection, testing and quality control during production. This system, which is devised and supervised by ISI and operated by the producer, has the further safeguard that the products as actually marketed are continuously checked by ISI for conformity to the standard. Details of conditions, under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

7.2 Packing — The thermometers shall be packed as agreed to between the purchaser and the supplier.

8. TESTING AND INSPECTION

8.1 Each thermometer shall individually comply with all the requirements of this specification. The scale and interval error tests shall be carried out in accordance with IS : 6274-1971*.

*Method of calibrating liquid-in-glass thermometers.

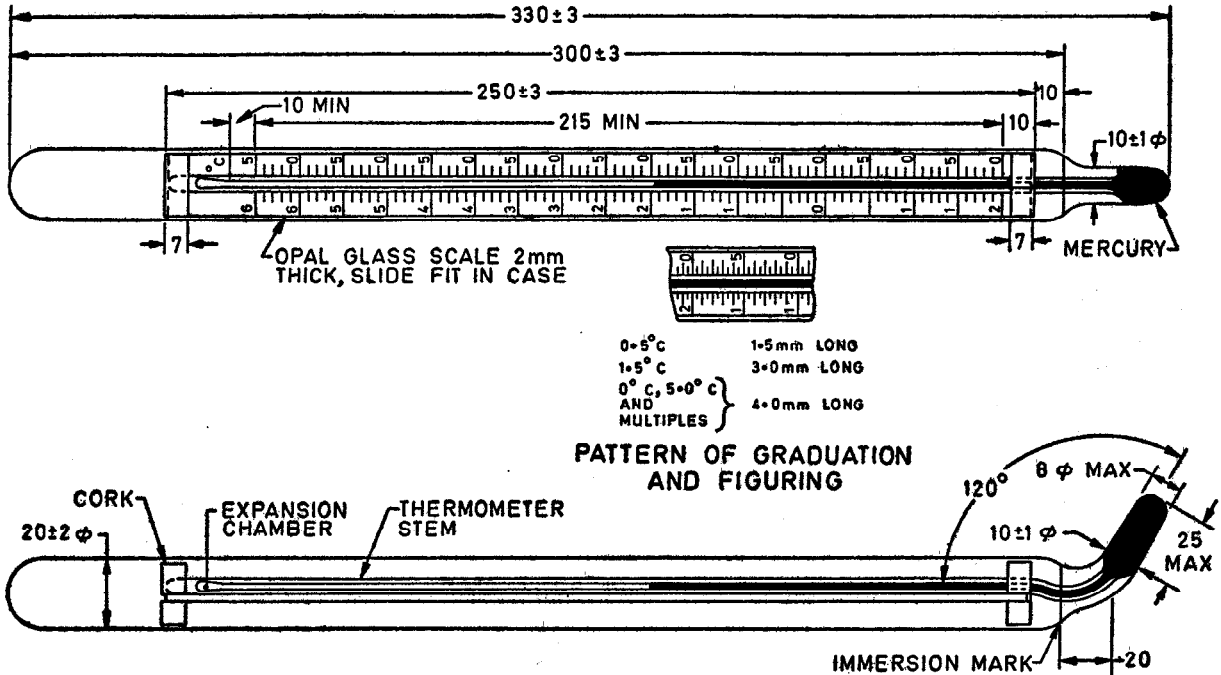
TABLE I DIMENSIONAL REQUIREMENTS OF SOIL THERMOMETERS

(Clause 5.3)

Sl No. (1)	PARTICULARS (2)	REQUIREMENTS								
		(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
i)	Designation	ST/ES-S	ST/SS-S	ST/ES-5	ST/SS-5	ST/ES-10	ST/SS-10	ST/ES-20	ST/SS-20	ST/SS-50 and ST/SS-100
ii)	Nominal range, °C	- 20 to + 65	- 20 to + 65	- 20 to + 65	- 20 to + 65	- 20 to + 65	- 20 to + 65	- 20 to + 65	- 20 to + 65	- 20 to + 50
iii)	Smallest scale division, °C	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
iv)	Overall length, mm	330 ± 3	330 ± 3	365 ± 4	365 ± 4	425 ± 5	425 ± 5	535 ± 6	535 ± 6	338 ± 3
v)	Length of the main scale, mm, <i>Min</i>	215	215	215	215	215	215	215	215	175
vi)	Length of the bulb, mm, <i>Max</i>	25	25	25	25	25	25	25	25	—
vii)	External dia- meter of the bulb, mm, <i>Max</i>	8	8*	8	8*	8	8*	8	8*	10 ± 1†
viii)	External dia- meter of the stem, mm	—	6 to 8	—	6 to 8	—	6 to 8	—	6 to 8	6.0 ± 0.5
ix)	Distance of the immersion mark from the top of the bulb, mm	20	20	60	60	115	115	230	230	—

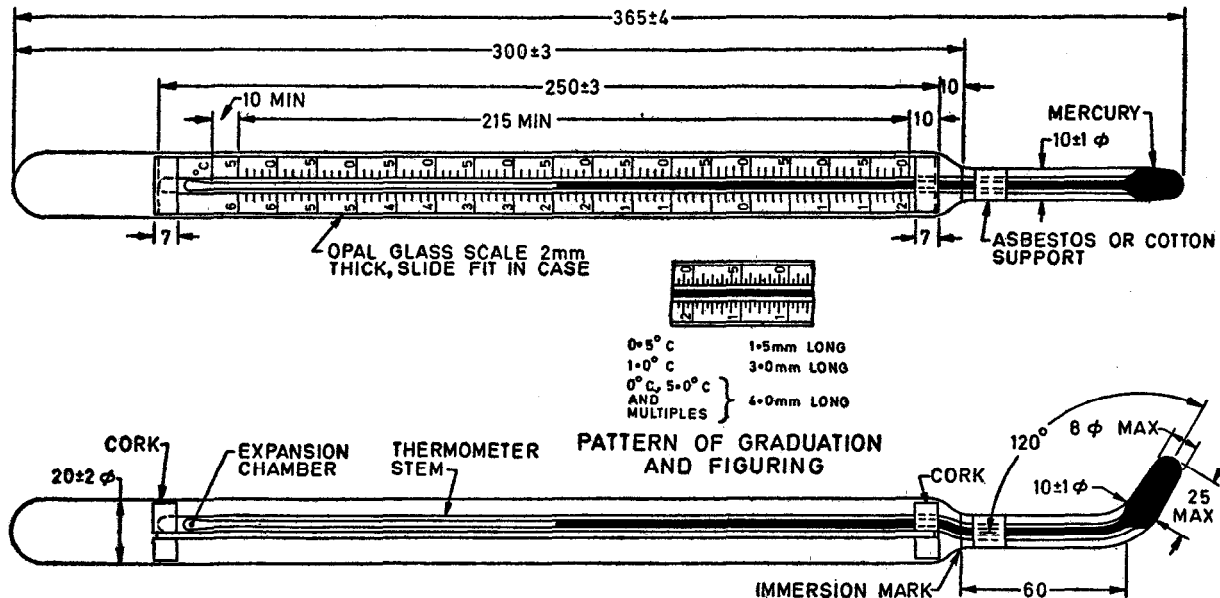
*Bulb diameter shall be less than that of the stem.

†Spherical bulb.



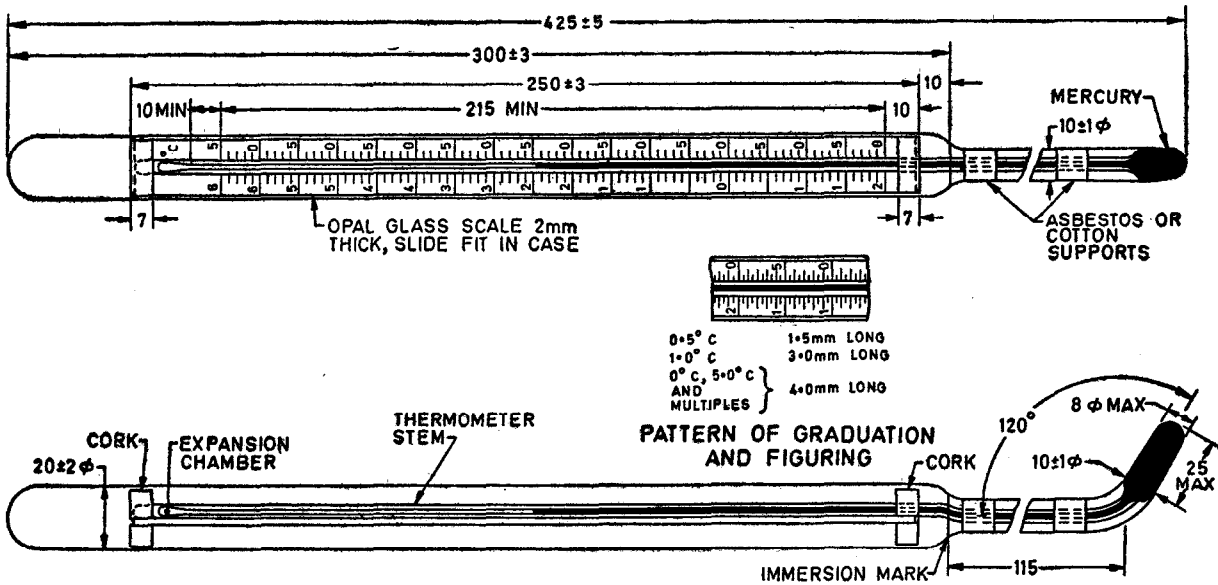
All dimensions in millimetres.

FIG. 1 SOIL THERMOMETER, ENCLOSED-SCALE, 120° BENT, FOR SURFACE, RANGE -20 TO $+65^\circ\text{C}$



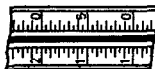
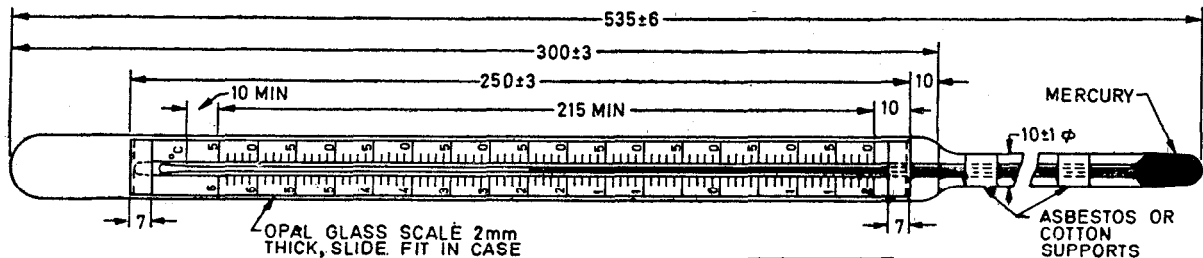
All dimensions in millimetres.

FIG. 2 SOIL THERMOMETER, ENCLOSED-SCALE, 120° BENT, FOR 5 cm DEPTH, RANGE -20 TO +65°C



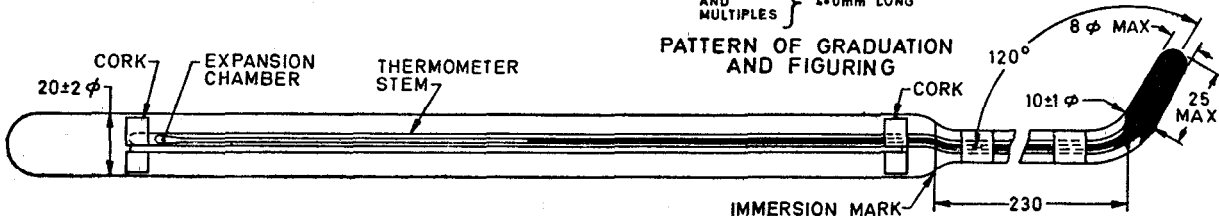
All dimensions in millimetres.

FIG. 3 SOIL THERMOMETER, ENCLOSED-SCALE, 120° BENT, FOR 10 cm DEPTH, RANGE - 20 TO + 65°C



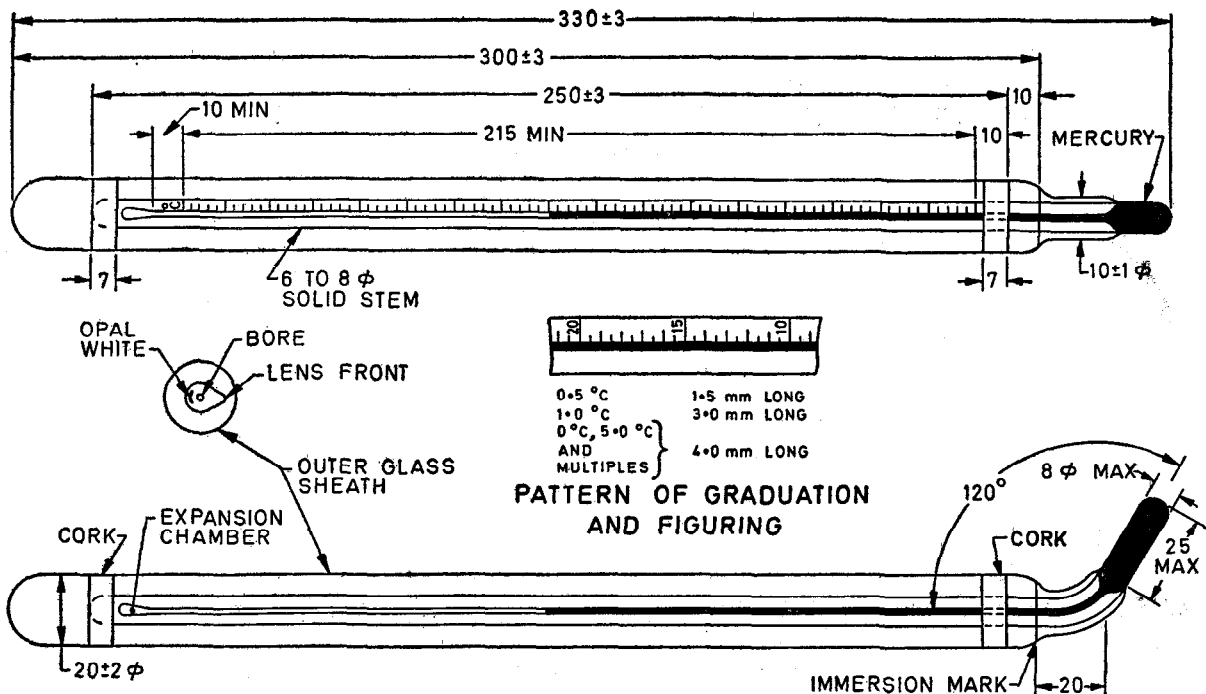
0.5°C 1.0mm LONG
 1.0°C 3.0mm LONG
 0°C, 5.0°C } 4.0mm LONG
 AND
 MULTIPLES

PATTERN OF GRADUATION AND FIGURING



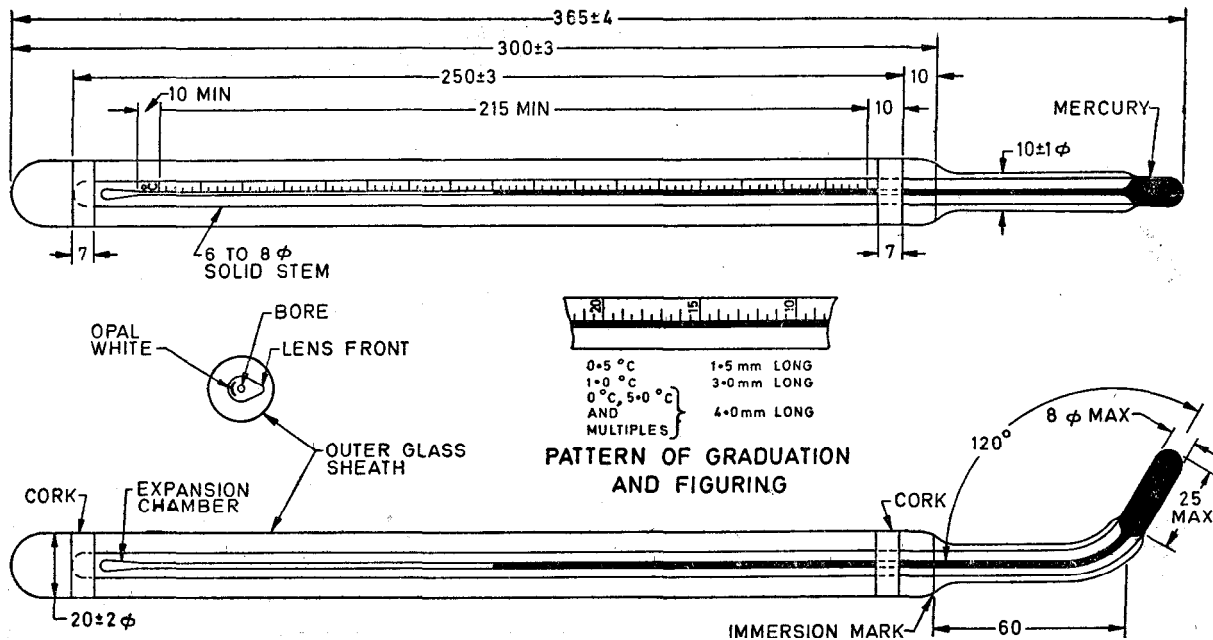
All dimensions in millimetres.

FIG. 4 SOIL THERMOMETER, ENCLOSED-SCALE, 120° BENT, FOR 20 cm DEPTH, RANGE - 20 TO + 65°C



All dimensions in millimetres.

FIG. 5 SOIL THERMOMETER, SHEATHED, SOLID-STEM, 120° BENT, FOR SURFACE, RANGE - 20 TO + 65°C



All dimensions in millimetres.

FIG. 6 SOIL THERMOMETER, SHEATHED, SOLID-STEM, 120° BENT, FOR 5 cm DEPTH, RANGE -20 TO $+65^\circ\text{C}$

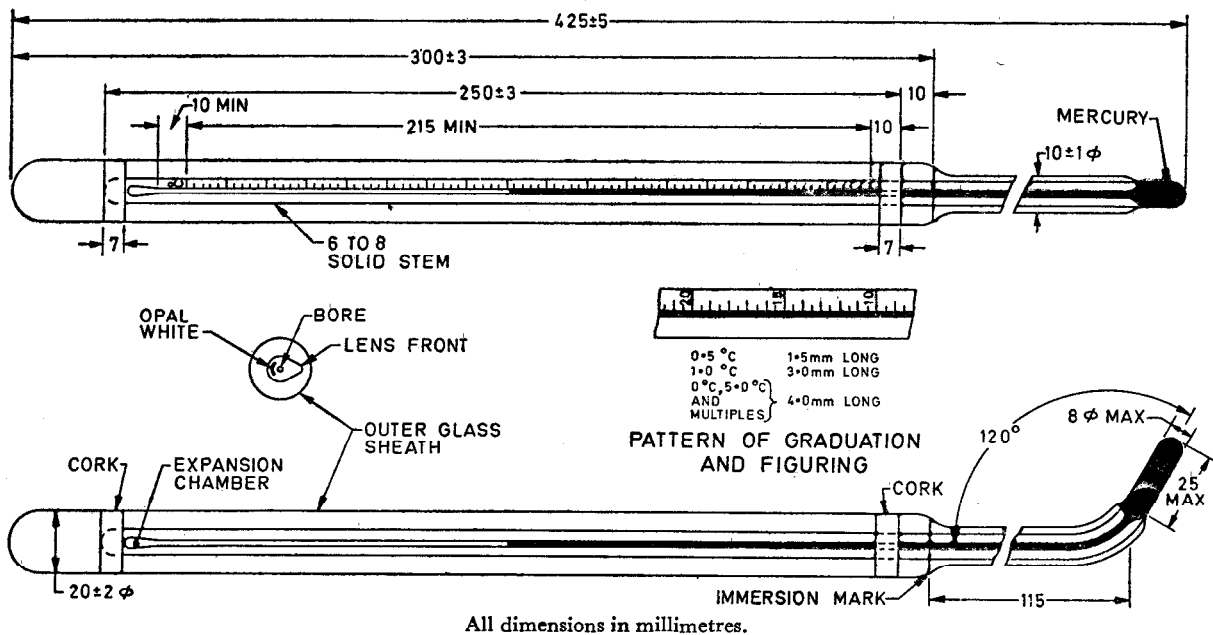


FIG. 7 SOIL THERMOMETER, SHEATHED, SOLID-STEM, 120° BENT, FOR 10 cm DEPTH, RANGE: -20 TO $+65^\circ \text{C}$

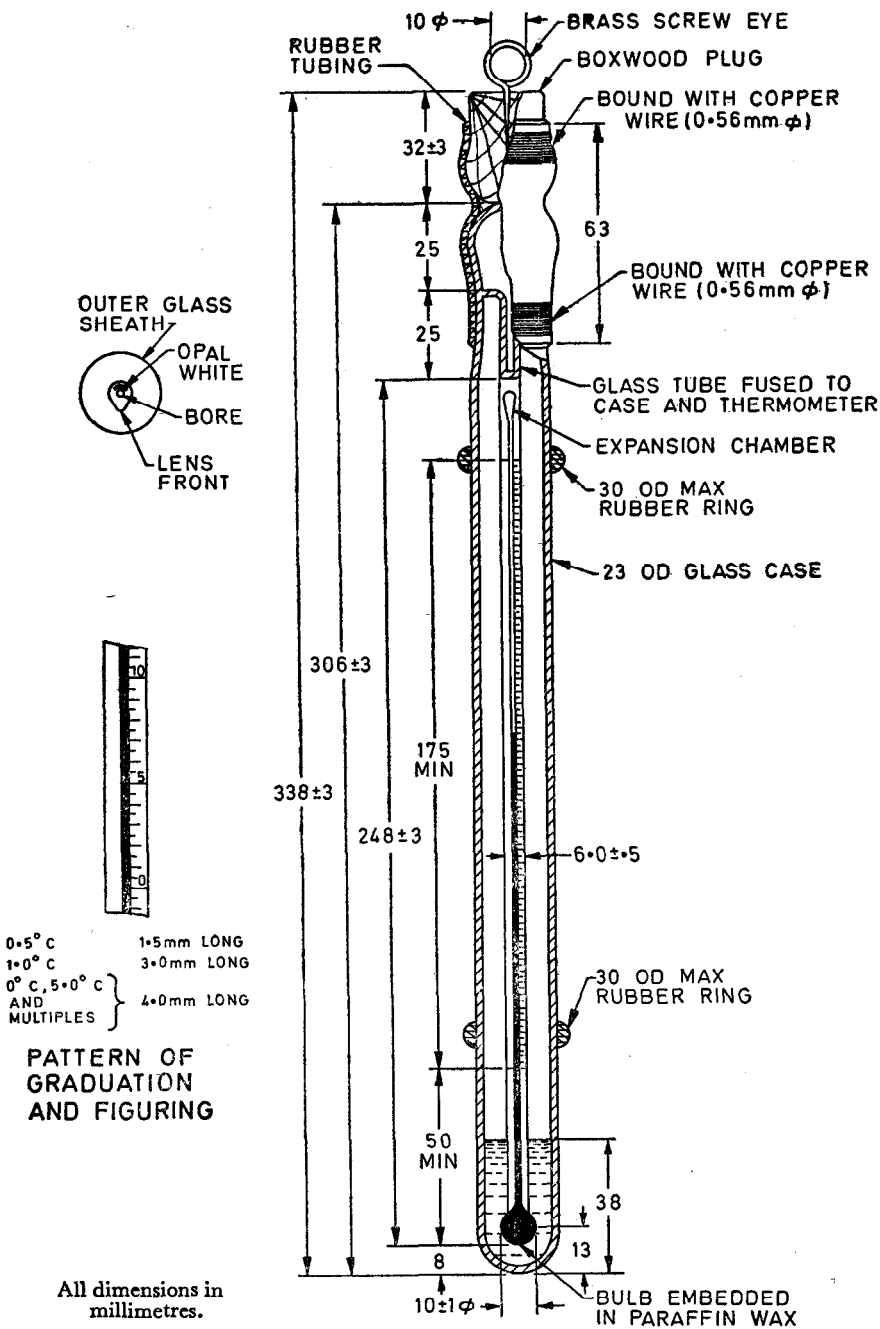
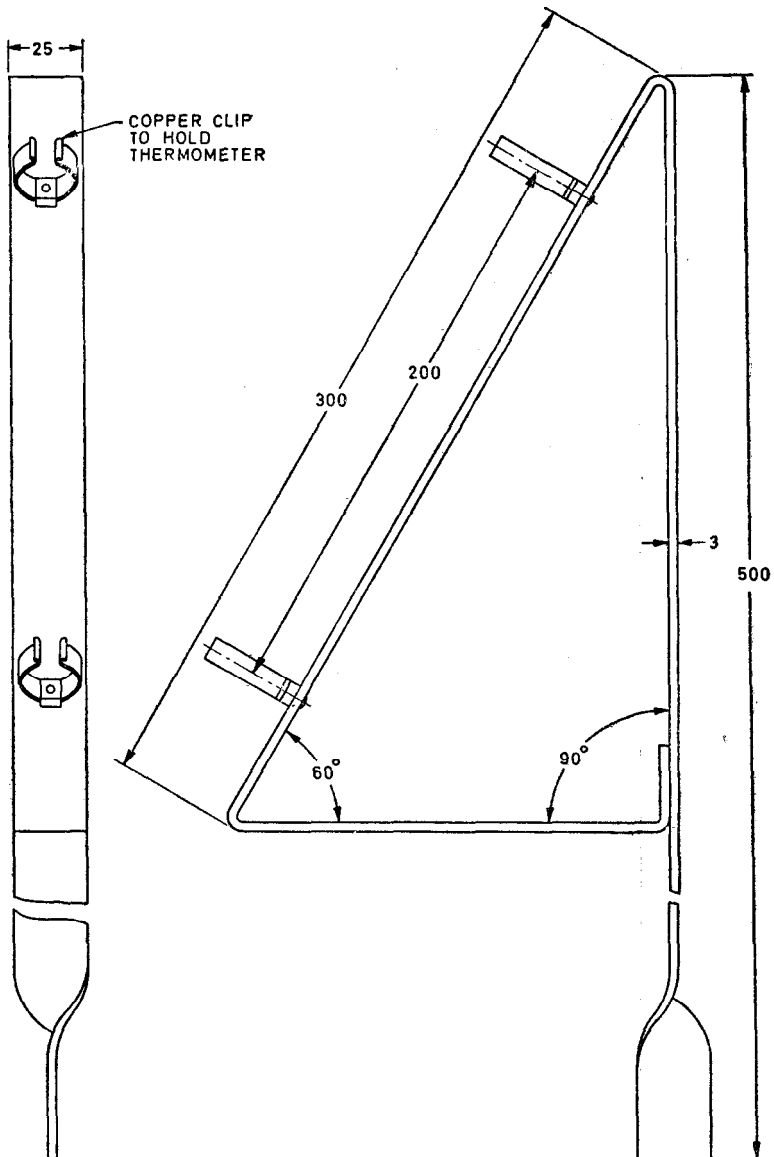


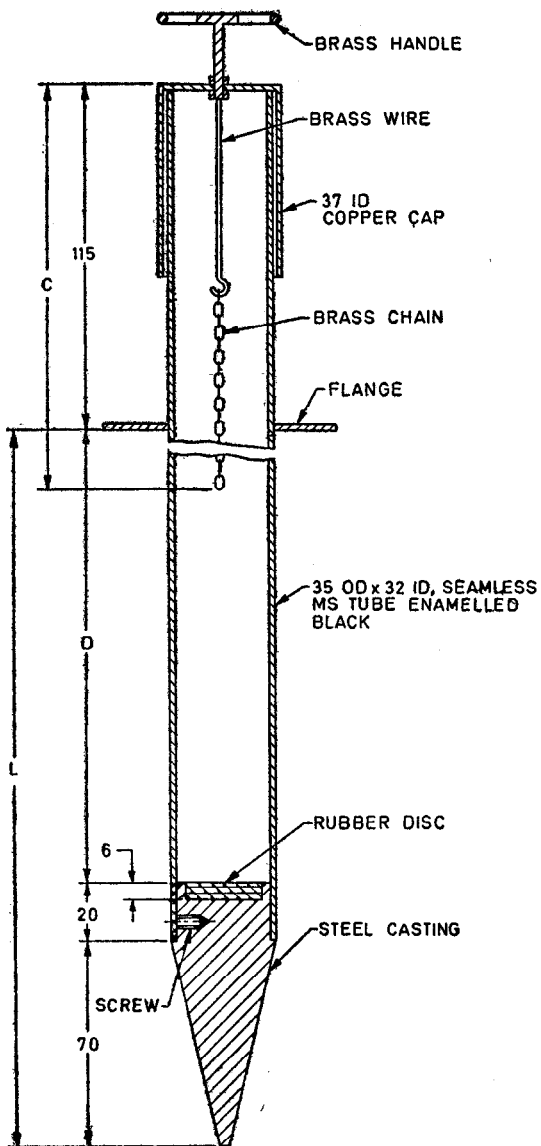
FIG. 9 SOIL THERMOMETER FOR 50 AND 100 cm DEPTHS, RANGE - 20 TO + 50°C



Material : Mild steel flat, painted black

All dimensions in millimetres.

FIG. 10 TRIANGULAR STAND FOR SOIL THERMOMETERS, 120° BENT, FOR SURFACE, 5, 10 AND 20 cm DEPTHS



All dimensions in millimetres.

	FOR 50 cm DEPTH	FOR 100 cm DEPTH
<i>D</i>	513	1 013
<i>L</i>	603	1 103
<i>C</i>	280	780

FIG. 11 IRON TUBE FOR SOIL THERMOMETERS, 50 AND 100 cm DEPTHS

**INDIAN STANDARDS
ON
THERMOMETERS**

IS:

- 1672-1967 Floating dairy thermometers (*first revision*)
2480-1964 General pressure glass thermometers
2627-1963 Glossary of terms relating to liquid-in-glass thermometers
3055-1965 Clinical thermometers
4529-1968 Glass tubes for medical thermometers
4610-1968 Glass tubes for general purpose and reference thermometers
4825-1968 Laboratory and reference thermometers
5681-1970 General meteorological thermometers, liquid-in-glass
5725-1970 Psychrometers, unventilated (dry and wet bulb hygrometers)
6017-1971 Thermometer for whirling psychrometers
6274-1971 Methods of calibrating liquid-in-glass thermometers
6500-1972 Thermometer for measurement of sea surface temperature
6592-1972 Soil thermometers

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