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Liquid-in-glass laboratory thermometers — Principles of design, construction and use

Thermomètres de laboratoire à dilatation de liquide dans une gaine de verre — Principes de conception, de construction et d'utilisation

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FOREWORD

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 386 was developed by Technical Committee ISO/TC 48, *Laboratory glassware and related apparatus*, and was circulated to the member bodies in May 1976.

It has been approved by the member bodies of the following countries :

Australia	Ireland	Romania
Austria	Israel	South Africa, Rep. of
Belgium	Italy	Spain
Canada	Korea, Rep. of	Turkey
Chile	Mexico	United Kingdom
France	Netherlands	U.S.A.
Germany	Philippines	U.S.S.R.
Hungary	Poland	

The member body of the following country expressed disapproval of the document on technical grounds :

Czechoslovakia

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Liquid-in-glass laboratory thermometers — Principles of design, construction and use

1 SCOPE AND FIELD OF APPLICATION

This International Standard sets out principles for the design, construction and use of liquid-in-glass laboratory thermometers.

Each thermometer consists of a glass bulb filled with liquid and connected with a glass capillary tube. A scale is associated with the tube in such a way that the temperature can be read from the position of the liquid surface in the tube.

2 TYPES OF THERMOMETER

Two types of liquid-in-glass thermometer are described :

2.1 Solid-stem thermometer

Thermometer having a thick-walled capillary stem, on which the scale is etched or marked.

2.2 Enclosed-scale thermometer

Thermometer having a capillary stem adjacent to a separate strip bearing the scale, both being enclosed in a protective sheath. There are other types of thermometer with separate but external scales; these however do not fall within the scope of this International Standard.

3 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 Conférence générale des poids et mesures, and in accordance with the International System of Units (SI).

4 CONDITIONS OF IMMERSION

In measuring the temperature of a medium by means of liquid-in-glass thermometers, the following methods are used.

4.1 Partial immersion

4.1.1 The thermometer is immersed to a prescribed depth in the medium so that not all the liquid column is immersed in the medium.

4.1.2 The emergent liquid column is that in the part of the capillary tube which is filled with liquid but not immersed in the medium.

4.1.3 The adopted value of the mean temperature of the emergent liquid column shall be specified to provide reference for graduation, calibration and use of the thermometer. Either this temperature may be the same for all scale readings, or different temperatures may be specified applicable to different points of the scale.

4.2 Total column immersion (total immersion)

The entire liquid column is immersed in the medium so that the top of the liquid column is in the same plane as the surface of the medium. (For practical considerations, see annex B, clause B.2.)

4.3 Complete immersion

The entire thermometer is immersed in the medium.

5 GLASS

The thermometer shall be made of suitable thermometric glass selected and processed so that the finished thermometer shows the following characteristics.

5.1 Stress in the glass of the bulb, capillary stem and, where appropriate, the protective sheath shall be reduced to a level sufficient to minimize the possibility of fracture due to thermal or mechanical shock.

5.2 The bulb glass shall be stabilized by suitable heat treatment to ensure that the accuracy requirements of 10.1 and 10.3 can be met.

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

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

6 LIQUID FILLING

The general requirements for the liquid filling shall include the following.

6.1 There shall be no freezing or partial freezing of the liquid filling throughout the temperature range under the pressures prevailing in the thermometer.

6.2 The liquid shall be free from any contamination likely to interfere with the proper functioning of the thermometer.

6.3 The boiling point of the liquid shall be high enough to minimize vaporization under the conditions prevailing in the thermometer.

6.4 For liquids which wet glass, additional requirements are as follows.

6.4.1 The physical properties of the liquid shall be such as to ensure that the drainage time when the thermometer is cooled, is within specified limits.

6.4.2 If the liquid is artificially coloured, a light-fast dye which does not stain the glass shall be used.

7 GAS FILLING

When gas filling is employed above the liquid filling, a dry gas shall be used at a pressure which raises the boiling point of the liquid sufficiently to ensure that the requirements of 6.3 are satisfied. In the case of mercury filling the gas shall be inert.

8 CONSTRUCTION

8.1 Shape

The thermometers shall be straight and their external cross-section approximately circular. For special thermometers, deviation from the straight shape and circular cross-section is permitted.

8.2 Top finish

The top of the thermometer may have a plain finish or a glass ring or button (see figure 1). The outer diameter of the ring or button shall not exceed that of the stem.

8.3 Enamel backing

For solid-stem thermometers, the stem may incorporate an enamel backing 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 lines.

8.4 Strip bearing the scale

For enclosed-scale thermometers, the strip bearing the scale shall be of a material suitable for the temperature to be measured and compatible with the method of fixing the strip. It shall be placed tightly against the capillary tube inside the sheath and shall be firmly and securely fastened at the top of the thermometer. A suitable method of fixing is by fusing a glass tube or rod to the sheath and to the upper end of the strip bearing the scale, while the lower end of the strip shall be freely held in a suitable saddle. Alternatively it shall be fixed inside the sheath in any other suitable manner that also allows for differential expansion (see figure 2 for recommended designs).

8.5 Capillary tube

The inside of the capillary tube shall be smooth. The cross-sectional area of the bore shall not show variations from the average greater than 10 %. The size of the bore shall be such that when the temperature is rising at a specified uniform rate, any jumping of the meniscus does not exceed a specified proportion of the graduation interval.

8.6 Enlargement of bore

No expansion or contraction chamber or other enlargement of the bore shall be so located as to produce any variation (greater than that permitted in 8.5) in the cross-section of the capillary tube in the scale ranges, and unless otherwise specified (see 8.7 and 8.8) there shall be at least 5 mm of unchanged capillary tube between any enlargement of the bore and any adjacent scale line. In the case of partial immersion thermometers no variation (greater than that permitted in 8.5) in the cross-section of the capillary tube is allowed between the immersion line (see 9.2) and the first scale line above it.

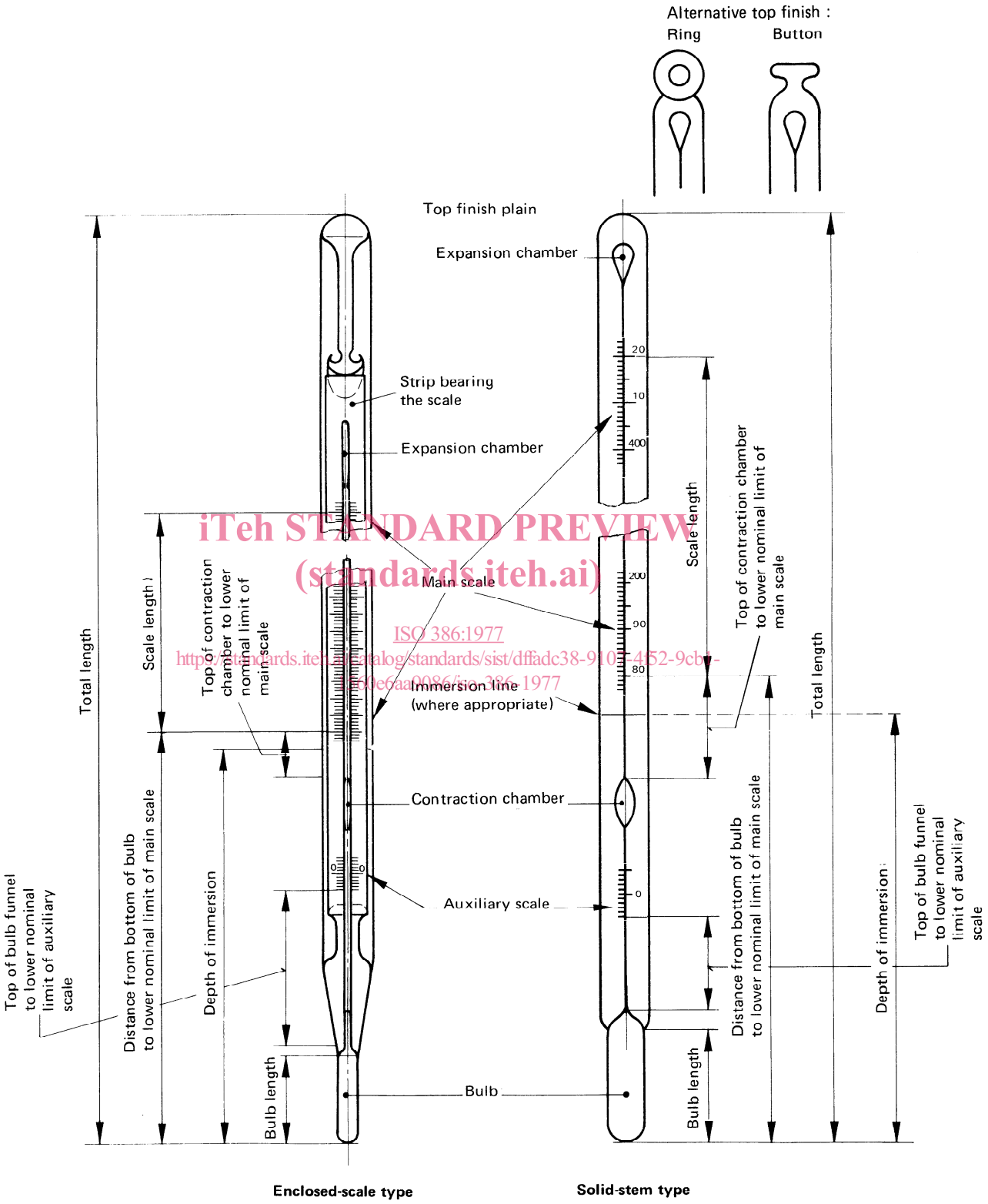

FIGURE 1 — **General design and terminology for liquid-in-glass thermometers**

2.1 2.2 2.3 2.4 2.5 2.6

2.1 with glass saddle and spring (Fuess top finish).

2.2 with fused-in glass tube (Richter top finish).

2.3 with fused-in glass pin.

2.4 cork-glass top finish.

2.5 cork and metal cap top finish.

2.6 with glass saddle and spring in metal support with cap.

FIGURE 2 — **Top finish and method of fixing the strip bearing the scale of enclosed-scale thermometers**

8.7 Expansion volume

A thermometer ought not to be heated above its upper nominal limit of scale because it may be damaged and may require recalibration even though it has not burst and any damage may not be visible. To minimize the effect of being accidentally overheated, and to provide for the exceptional case of a thermometer whose temperature range is below ambient being stored at ambient temperature, an expansion volume shall be provided at the top of the capillary tube.

This volume should preferably consist of an expansion chamber with at least 10 mm of unchanged capillary tube between the highest scale line and the commencement of the widening of the capillary tube. Such a chamber shall be pear-shaped with the hemisphere at the top. The approximate capacity of the expansion chamber shall be specified in terms of either the equivalent length of capillary tube or the corresponding temperature interval. In the case of gas filling, the expansion volume may consist of at least 30 mm of unchanged capillary tube above the highest scale line.

8.8 Contraction chamber

To prevent the liquid withdrawing into the bulb during storage or to allow the inclusion of an auxiliary scale, the bore may be enlarged above the bulb or above the auxiliary scale in an elongated manner to form a contraction chamber. This enlargement may be situated immediately above the bulb in the case of enclosed-scale thermometers but should preferably be separated from the bulb by a short length of capillary tube in the case of solid-stem thermometers. Where the enlargement is situated above an auxiliary scale, it shall be not less than 5 mm above that scale.

If the lower nominal limit of the scale is below 100 °C, the distance from the top of the contraction chamber to the first scale line of the main scale shall be not less than 10 mm.

In the case of partial immersion thermometers, this distance (10 mm) shall be measured either to the first scale line of the main scale or to the immersion line, whichever is the lesser distance. If the lower nominal limit of the scale is 100 °C or above, the corresponding distance shall be not less than 20 mm.

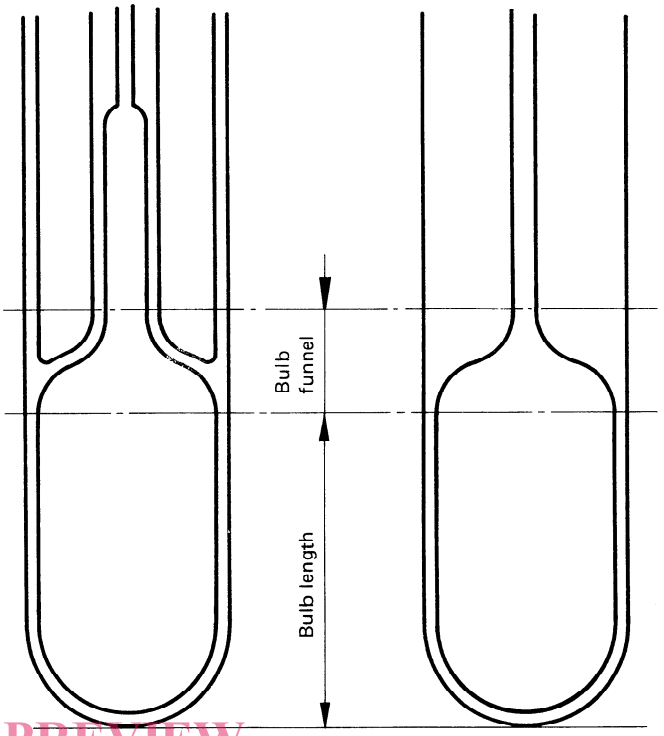

FIGURE 3 – **Definition of bulb length**

8.9 Specification of dimensions (see figure 1)

The following dimensions of a thermometer should be specified as required. These dimensions are consistent with producing a well designed thermometer but for specific purposes it may be necessary to state tolerances with these dimensions or to specify additional dimensions.

8.9.1 *Total length*

This is the overall length of the thermometer, including bulb and top finish. The maximum dimension only shall be specified.

8.9.2 *Bulb length*

The bulb length is defined (see figure 3) as the distance from the bottom of the bulb to the point at which the internal bulb diameter begins to decrease as the bulb merges into the stem. In general the minimum dimension only shall be specified.

8.9.3 *Distance from top of bulb funnel to lower nominal limit of scale* (see figure 3)

If the thermometer has more than one scale (for example main scale and auxiliary scale) this distance shall be to the lower nominal limit of the lowest scale. The minimum dimension only shall be specified. This distance shall be at least :

– 30 mm for thermometers having the lower nominal limit 100 °C or above;

– 13 mm for thermometers having the lower nominal limit less than 100 °C.

8.9.4 *Scale position*

The minimum dimension for the distance from the bottom of the bulb to the lower nominal limit of the main scale shall be specified.

8.9.5 *Scale length*

The scale length is the distance between the nominal limits of the main scale. (The nominal limits are marked with long lines and may or may not be figured.) The minimum dimension only shall be specified.

If the thermometer is intended to be read with normal or corrected eyesight but without (or with comparatively simple) optical equipment, this minimum scale length should be specified so as to obtain a distance between the centres of consecutive scale lines of preferably not less than 0,8 mm for solid-stem thermometers and 0,6 mm for enclosed-scale thermometers.

NOTE – This latter distance is smaller owing to the smaller parallax error which is likely with this type of thermometer.

8.9.6 *Depth of immersion* (if required)

To be measured from the bottom of the bulb.

8.9.7 *Diameter of stem or sheath*

The maximum and minimum dimensions shall be specified.