DRAFT INTERNATIONAL STANDARD
ISO/DIS 384

ISO/TC **48** Secretariat: **DIN**

Voting begins on: **2013-10-31** Voting terminates on: **2014-03-31**

Laboratory glass and plastics ware — Principles of design and construction of volumetric instruments

Matériel de laboratoire en verre ou en plastique — Principes de conception et de construction d'instruments volumétriques

[Revision of first edition (ISO 384:1978)]

ICS: 17.060

ISO/CEN PARALLEL PROCESSING

This draft has been developed within the International Organization for Standardization (ISO), and processed under the **ISO lead** mode of collaboration as defined in the Vienna Agreement.

This draft is hereby submitted to the ISO member bodies and to the CEN member bodies for a parallel five month enquiry.

Should this draft be accepted, a final draft, established on the basis of comments received, will be submitted to a parallel two-month approval vote in ISO and formal vote in CEN.

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

Reference number
ISO/DIS 384:2013(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 384 was prepared by Technical Committee ISO/TC 48, Laboratory equipment and by Technical Committee CEN/TC 332, Laboratory equipment in collaboration.

This second edition cancels and replaces the first edition (ISO 384:1978), which has been technically revised to incorporate the following modifications.

a) Volumetric instruments made from plastics have been added to the scope.

b) Volumetric instruments of class AS have been added.

c) The thickness of graduation lines has been modified.

d) The basic principles for construction have been modified such that they comply with the product standards ISO 1042, ISO 648, ISO 835, ISO 385, ISO 4788 and ISO 4787.

e) The relation between maximum permissible error and the inner diameter has been specified by an equation.

f) Annex A explaining that relation has been reworded.

Laboratory glass and plastics ware — Principles of design and construction of volumetric instruments

1 Scope

This International Standard sets out principles for the design of volumetric instruments manufactured from glass or from plastics in order to facilitate the most reliable and convenient use to the intended degree of accuracy.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 383, *Laboratory glassware — Interchangeable conical ground joints*.

ISO 4787, *Laboratory glassware — Volumetric instruments — Methods for testing of capacity and for use*

ISO/IEC Guide 99, *International Vocabulary of Metrology — Basic and general concepts and associated terms (VIM)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC Guide 99 apply.

4 Unit of volume and reference temperature

4.1 Unit of volume

The unit of volume shall be the millilitre (ml), which is equivalent to one cubic centimetre (cm^3).

4.2 Reference temperature

The standard reference temperature, i.e. the temperature at which the volumetric instrument is intended to contain or deliver its volume (capacity), shall be 20 °C.

When the volumetric instrument is required for use in a country which has adopted a standard reference temperature of 27 °C, this figure shall be substituted for 20 °C.

NOTE The capacity of volumetric instruments varies with change of temperature. A volumetric instrument which was adjusted at 20 °C, but used at 27 °C, would show an extra error of only 0,007 % if it is made of borosilicate glass having a coefficient of cubical thermal expansion of $9{,}9 \times 10^{-6}$ $°C^{-1}$ and of 0,02 % if it is made of soda-lime glass having a coefficient of cubical thermal expansion of 27×10^{-6} $°C^{-1}$. These errors are smaller than the limits of error for most volumetric instruments. It follows, therefore, that the reference temperature is of minor importance in practical use. However, when performing calibrations, it is important to refer to the reference temperature.

5 Volumetric accuracy

5.1 There are two classes of accuracy:

— the higher grade shall be designated "class A" or "class AS";

— the lower grade shall be designated "class B".

5.2 The maximum permissible error shall be specified for each type of volumetric instrument in regard to the method and purpose of use and the class of accuracy.

5.3 The numerical values of maximum permissible error for volumetric instruments for general purposes shall be preferably chosen from the series 10 – 12 – 15 – 20 –25 – 30 – 40 – 50 – 60 – 80, or a suitable decimal multiple thereof.

NOTE This series of preferred numbers has been adopted because decimal sub-multiples of some of the unrounded numbers, for example 31,5, would appear to imply a degree of precision which is not intended and which could not be measured in practice.

5.4 The maximum permissible error specified for a series of sizes of an volumetric instrument should provide a reasonably uniform progression in relation to capacity.

5.5 The maximum permissible error permitted for class B should, in general, be approximately twice as permitted for class A or AS.

5.6 For volumetric instruments having a scale, the maximum permissible error for either class of accuracy shall not exceed the volume equivalent (see Annex A) of the smallest scale division.

5.7 The maximum permissible error *MPE* for class A or AS depends on the internal diameter *D* (in millimetres) at the related graduation line and shall not be smaller than derived by equation (1):

$$MPE \geq \frac{\pi}{4} D^2 \ (0{,}4 + 0{,}01D) \tag{1}$$

The corresponding class B limit shall be derived in accordance with 5.5.

NOTE The above formula applies for the most common volumetric instruments which have a circular cross-section, but may be transferred to non circular cross-sections as well. See Annex A.

5.8 In addition to 5.7 the maximum permissible error specified for any volumetric instrument designed to deliver shall also be not less than four times the standard deviation determined experimentally by an experienced operative from a series of at least ten consecutive determinations of delivered capacity on the same volumetric instrument, carried out strictly in accordance with the method specified for this volumetric instrument in ISO 4787.

6 Methods of calibration and use

The method of calibration and use for each type of volumetric instrument is extensively described in ISO 4787.

The general procedure is based upon a gravimetric determination of the volume of water, either contained in or delivered by the volumetric instrument under test. This volume of water is calculated from its mass under consideration of air buoyancy and water density.

Volumetric instruments manufactured from plastics should be considered to be calibrated more often than glass instruments, because of the lower long-term stability of plastic instruments.

7 Construction

7.1 Material

Volumetric instruments shall be constructed of glass or plastic of suitable chemical and thermal properties. They shall be as free as possible from visible defects and shall be reasonably free from internal stress.

7.2 Wall thickness

The volumetric instruments shall be sufficiently robust in construction to withstand usual laboratory usage and the wall thickness shall show no gross departure from uniformity.

7.3 Shape

All volumetric instruments shall be of a shape which will facilitate the intended use, and should preferably be of circular cross-section.

7.4 Capacity

7.4.1 The numerical values of capacity of volumetric instruments for general purposes should preferably be chosen from the series 10 – 20 – 25 – 50, or a decimal multiple or sub-multiple thereof.

The capacity of volumetric instruments for special applications may have differing values; there are e.g. pipettes with capacities of 3 ml to 9 ml.

7.4.2 The numerical value of the volume equivalents of the smallest division on volumetric instruments having a scale shall be chosen from the series 1 – 2 – 5, or a decimal multiple or sub-multiple thereof.

7.4.3 In the case of a special purpose volumetric instrument which is to be graduated for direct reading of capacity when used with a specific liquid other than water, the specification should preferably indicate the corresponding capacity when used with pure water, so that the latter can be used for calibration.

7.5 Stability

Volumetric instruments provided with a flat base shall stand vertically without rocking or spinning when placed on a level surface and, unless specified otherwise, the axis of the graduated portion of the vessel should be vertical.

7.6 Delivery jets

7.6.1 Delivery jets at the lower end of volumetric instruments should be strongly constructed either with a smooth and gradual taper or a capillary end, both without sudden constriction at the orifice which could give rise to turbulent outflow.

7.6.2 The end of the jet shall be finished by one of the methods listed below in order of preference:

a) smoothly ground square with the axis, slightly bevelled on the outside and polished;

b) smoothly ground square with the axis and slightly bevelled on the outside;

c) cut square with the axis and polished.

A fire-polished finish of glass jets reduces the danger of chipping in use, but should not result in sudden constriction or in undue stress.

7.6.3 The jet shall be made either from glass tubing or from suitable plastics material. It shall preferably form an integral part of the volumetric instrument. Otherwise, the jet shall be clearly identified to link it to the related volumetric instrument or, if sufficient, to the nominal size of the volumetric instrument.

7.7 Stoppers

7.7.1 Glass stoppers should preferably be ground so as to be interchangeable, in which case the ground portions shall comply with ISO 383. If individually fitted, they shall be well ground so as to prevent leakage, preferably with a taper of approximately 1/10.

7.7.2 Stoppers of a suitably inert plastics material may be permitted as an alternative to glass. In such cases, the glass or plastic socket into which the stopper fits should preferably comply with ISO 383.

7.8 Stopcocks or similar devices

7.8.1 Stopcocks and similar devices shall be designed to permit smooth and precise control of outflow and to prevent a rate of leakage greater than that allowed in the specification for the volumetric instrument.

7.8.2 Stopcocks and similar devices shall be made from glass or from suitable inert plastics material.

7.8.3 All-glass stopcocks shall have the key and barrel finely ground preferably to a taper of 1/10 and shall comply with appropriate national or international specifications.

7.8.4 Glass stopcock barrels to receive plastics keys shall be polished internally and may have a taper of 1/5 or 1/10.

7.8.5 Stopcock components may be fitted with suitable retaining devices.

8 Linear dimensions

8.1 Linear dimensional requirements shall be specified for all volumetric instruments in such a way as to ensure that:

a) the volumetric instrument is convenient and satisfactory for its intended use;

b) in a series of sizes of a volumetric instrument, unnecessary inconsistencies in shape and proportions can be avoided;

c) a limitation is placed on the maximum inner diameter at the graduation line or lines (see 5.7 and Annex A). This limitation may be a direct limitation on the inner diameter or an indirect one by a minimum limitation on scale length;

d) the requirement for spacing of graduation lines specified in 10.1.2 is achieved;

e) the stability requirements of 7.4 can be achieved.

8.2 Dimensional requirements should not be more restrictive than is necessary to achieve the aims listed in 8.1. Linear dimensions shall be specified in millimetres.

8.3 In order to permit maximum freedom in manufacture within the restrictions imposed by 8.1, dimensions may be divided into two categories of importance and classified as "essential dimensions" and "recommended dimensions".

8.4 In a specification where these two categories of dimensions are used, the requirements of 8.1 c) and d) shall be included as essential dimensions.

8.5 The requirements of 8.1 b) can in many cases be ensured sufficiently by recommended dimensions.

8.6 Essential dimensions shall be expressed in specifications by one of the following ways, whichever is the most suitable or convenient:

a) a specified figure with tolerance;

b) a maximum and minimum figure;

c) a maximum or a minimum figure, if the other limit is unimportant or is controlled by other factors in the specification.

9 Graduation lines

9.1 Graduation lines and ringmarks shall be clean, permanent, uniform lines of specified thickness as described below.

9.2 For volumetric instruments with or without scale, a maximum thickness δ of graduation lines shall be specified according to the inner tube diameter *D* (in millimetres):

$$\delta \leq 0{,}4 \text{ mm for inner tube diameters of } D \leq 40 \text{ mm} \quad (2)$$

and

$$\delta \leq [(0{,}4 + 0{,}01\, D) / 2] \text{ mm for inner tube diameters of } D > 40 \text{ mm} \quad (3)$$

NOTE For volumetric instruments with non circular shaped cross-sections, see Annex A.

9.3 On volumetric instruments having a scale, the specified maximum thickness δ of lines shall not exceed one-half of the minimum distance *h* between the centres of adjacent lines:

$$\delta \leq h/2 \text{ mm} \quad (4)$$

9.4 All graduation lines shall lie in planes at right angles to the longitudinal axis of the graduated portion of the volumetric instrument. On volumetric instruments provided with a flat base, the graduation lines shall therefore lie in planes parallel to the base.

9.5 Graduation lines should preferably be situated not less than 5 mm from any change in diameter.

9.6 On volumetric instruments not having a scale, all graduation lines should extend completely round the circumference of the volumetric instrument, except that a gap, not exceeding 10 % of the circumference, may be permitted. In the case of an volumetric instrument which is restricted as to the usual direction of viewing in use, this gap should be at the right or left of the usual direction of view.

10 Scales

10.1 Spacing of graduation lines

10.1.1 There should be no evident irregularity in the spacing of graduation lines (except in special cases where the scale is on a conical or tapered portion of the volumetric instrument and a change of subdivision takes place).

10.1.2 The minimum distance *h* between the centres of adjacent graduation lines shall be not less than:

$$h \geq (0{,}8 + 0{,}02\, D) \text{ mm} \quad (5)$$

where *D* is the inner diameter of the tube in millimetres.

NOTE For non-circular cross-sections see Annex A.

10.2 Length of graduation lines (see Figure 2)

10.2.1 On volumetric instruments of circular cross-section having a scale, the length of the graduation lines shall be varied so as to be clearly distinguishable and shall be in accordance with the provisions of 10.2.2, 10.2.3 or 10.2.4.

10.2.2 Graduation pattern I

a) The length of the short lines should be approximately, but not less than, 50 % of the circumference of the volumetric instrument.

