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**INTERNATIONAL STANDARD**



**2971**

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**Tobacco and tobacco products — Cigarettes and filters —  
Determination of nominal diameter**

*Tabac et produits du tabac — Cigarettes et filtres — Détermination du diamètre nominal*

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## FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up 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.

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 2971 was drawn up by Technical Committee ISO/TC 126, *Tobacco and tobacco products*, and circulated to the Member Bodies in October 1972.

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It has been approved by the Member Bodies of the following countries :

Australia	Iran	ISO 2971:1976
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No Member Body expressed disapproval of the document.

# Tobacco and tobacco products — Cigarettes and filters — Determination of nominal diameter

## 0 INTRODUCTION

The determination of the diameter of cigarettes and filters is difficult to achieve with sufficient accuracy by usual metrology using a sliding caliper or a micrometer gauge, particularly because of :

- possible distortion during measurement,
- a slight ovality in practice of the cigarettes and filters.

Using the method specified in this International Standard, there is a difference of about 0,02 mm between the results obtained with a metal rod and those obtained with a filter rod, because of the roughness of the paper.

## 1 SCOPE

This International Standard specifies a method for determining the nominal diameter of cigarettes and filters by the pneumatic measuring head process.

## 2 FIELD OF APPLICATION

The method is generally applicable to cylindrically shaped cigarettes and filters.

NOTE — Errors may occur in the case of cigarettes or filters wrapped with papers of very high air permeability. These errors may be overcome by plugging the extremities of the test piece (capsule, paraffin wax, etc.).

## 3 REFERENCE

ISO 3402, *Tobacco and tobacco products — Atmospheres for conditioning and testing.*

## 4 DEFINITIONS

**4.1 nominal diameter of a cigarette or filter:** The diameter in millimetres of a metal measuring rod ground to

an accuracy of  $\pm 0,005$  mm giving in the same measuring head the same pressure reading (water height  $h$ ) as the cigarette or filter submitted to the measurement.

NOTE — By convention, it is accepted that the results obtained define the nominal diameter of cigarettes or filters which may possibly not be perfectly circular.

**4.2 nominal diameter of a measuring head ( $D_n$ ):** The diameter in millimetres of the metal measuring rod ground to an accuracy of  $\pm 0,005$  mm with which the reading is situated in the centre of the measuring range, this position corresponding to maximum sensitivity.

## 5 PRINCIPLE

Introduction of the test piece into a measuring head having a slightly larger circular cross-section through which compressed air is applied to the test piece, and determination of the loss of pressure, which is proportional to the diameter of the test piece.

After calibration, the water column may be directly graduated "in diameters": To each height  $h$  of the water column corresponds a value  $D$  of the diameter.

## 6 APPARATUS

**6.1 Conditioning chamber,** regulated in accordance with the requirements of ISO 3402.

**6.2 Pneumatic micromesurer or micrometer giving one reading<sup>1)</sup>,** or other similar apparatus.

**6.3 Device supplying compressed air,** equipped with a pressure stabilizer.

**6.4 Main jet<sup>2)</sup>.**

**6.5 Outlet connection,** with a diameter of about 12 mm.

1) See annex B.

2) See clause B.4 of annex B.

**6.6 Measuring head<sup>1)</sup>**

— inside diameter of the internal rings : nominal dimension + 0,30 mm;

— inside diameter of the external rings : nominal dimension + 0,25 mm.

NOTE — The external rings are used not directly for measuring, but as a centering device and as a protection for the internal rings; there is no risk of inadvertently inserting a test piece with too great a diameter.

**6.7 Set of cylindrical metal measuring rods, ground to an accuracy of ± 0,005 mm, graduated in diameter steps of 0,05 mm.**

**7 PROCEDURE**

**7.1 Conditioning of the test pieces**

Introduce the test pieces into the conditioning chamber (6.1) and keep them there until equilibrium is attained (see ISO 3402). For newly manufactured cigarettes, conditioning is not necessary.

**7.2 Determination**

Introduce the test piece so that its central third is in the middle of the measuring head (6.6) with appropriate nominal diameter  $D_n$ .

Read the result on the water column.

If it is suspected that paper of high air permeability has been used in the cigarette, cover the part of the test cigarette projecting beyond the centring rings with wax, a capsule or other suitable material before measurement, to prevent egress of air from that part of the cigarette.

**7.2.1 Scale of measurement**

The theoretical scale of measurement of a measuring head (6.6) extends from 0 to  $(D_n + 0,25 \text{ mm})$ , the upper limit corresponding to a mechanical impossibility.

The practical scale of measurement of a measuring head is limited to smaller values by the decreasing sensitivity ( $\Delta h / \Delta D_n$ ) of the determination when the diameter of the test piece is smaller than the nominal diameter of a measuring head ( $D_n$ ) (see in annex A the characteristic calibration curve of a measuring head).

Therefore the graduations on a scale should only be used within the approximate range of :

$$(D_n - 0,30 \text{ mm}) \text{ to } (D_n + 0,20 \text{ mm})$$

The useful range of nominal diameters of measuring heads,  $D_n$ , varies from 7 to 10,5 mm, but a certain overlapping of the scales of measurement of the different measuring heads is provided, with the result that it is always possible to operate other than at the limit of the scale on at least one measuring head.

**7.2.2 Calibration**

For each measuring head (6.6), calibrate the apparatus equipped with a given main jet (6.4), using a set of metal measuring rods (6.7).

Transfer to the graduated scale corresponding to each measuring head the value of the diameter  $D$  of the metal measuring rod corresponding to the water height  $h$  obtained.

If necessary, "smooth out" the calibration curve (see annex A) in order to reduce the slight experimental deviations noted.

NOTE — The calibration concerns only the measuring head (6.6) and the main jet (6.4).

The main jets (6.4) are calibrated. They shall comply with the standards in force. However, two main jets of the same dimensions may possibly not be absolutely identical, the deviations noted when measuring diameters rarely exceeding 0,01 mm in the vicinity of the nominal diameter  $D_n$  of a measuring head (6.6).

On the other hand it is recommended that the micromesurer (6.2) be retained after calibration, as slight differences may appear from one to another (equilibrium of the water column at "zero").

**8 EXPRESSION OF RESULTS**

Express the results in millimetres to the nearest 0,01 mm.

**9 TEST REPORT**

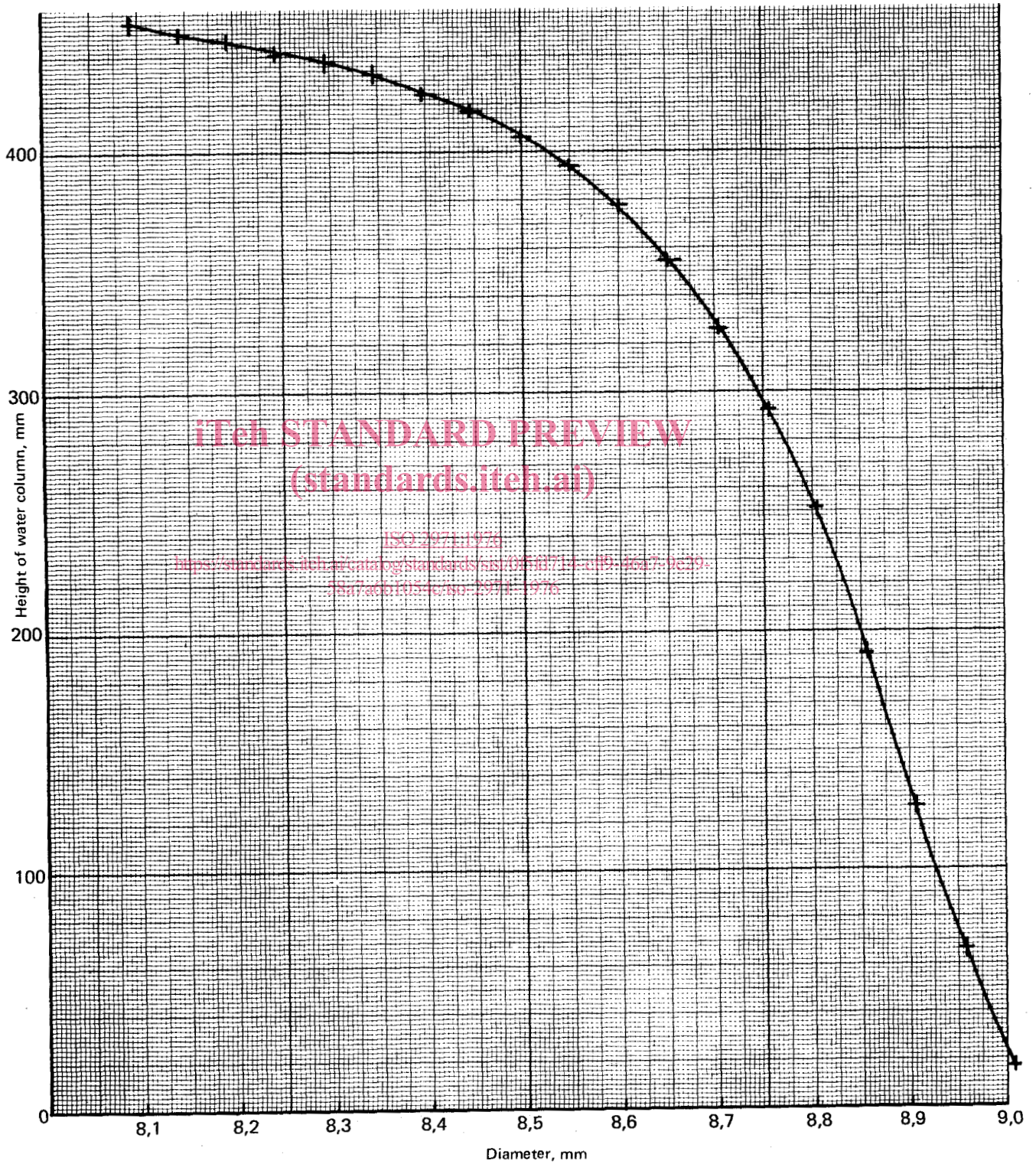
The test report shall indicate the method used and the results obtained. It shall, in addition, mention all the operational details not provided for in this International Standard or which are optional, as well as any incidents which may have influenced the results.

The conditioning atmosphere adopted shall be mentioned, as well as all the information necessary for the complete identification of the sample.

1) See annex B.

ANNEX A

CALIBRATION CURVE OF A MEASURING HEAD OF NOMINAL DIAMETER  $D_n = 8,80$  mm



ANNEXE B

APPARATUS

B.1 PRINCIPLE OF A MICROMEASURER



Two apertures with cross-section  $G$  and  $S$  are placed in series in an air circuit at constant pressure  $H$ . The pressure  $p$  which exists between the two apertures depends directly on the ratio of the cross-sections of these apertures. It is shown that

$$p = \frac{H}{1 + k (S/G)^2}$$

$G$  being the fixed cross-section of the main jet, the pressure  $p$  depends solely on  $S$  and the variations in  $p$  reflect the variations in  $S$ . In addition, if  $G$  is small, it is seen that slight variations in  $S$  bring about large variations in  $p$ .

$S$  is the outflow cross-section between the measuring head used and the test piece. The outflow at this aperture decreases as the diameter of the test piece increases. A given outlet section, and thus a certain pressure, corresponds to a given diameter. The scale of pressures can therefore be marked off directly in diameters on the water column (in practice  $H - p$  is measured); it is sufficient to calibrate the apparatus beforehand.

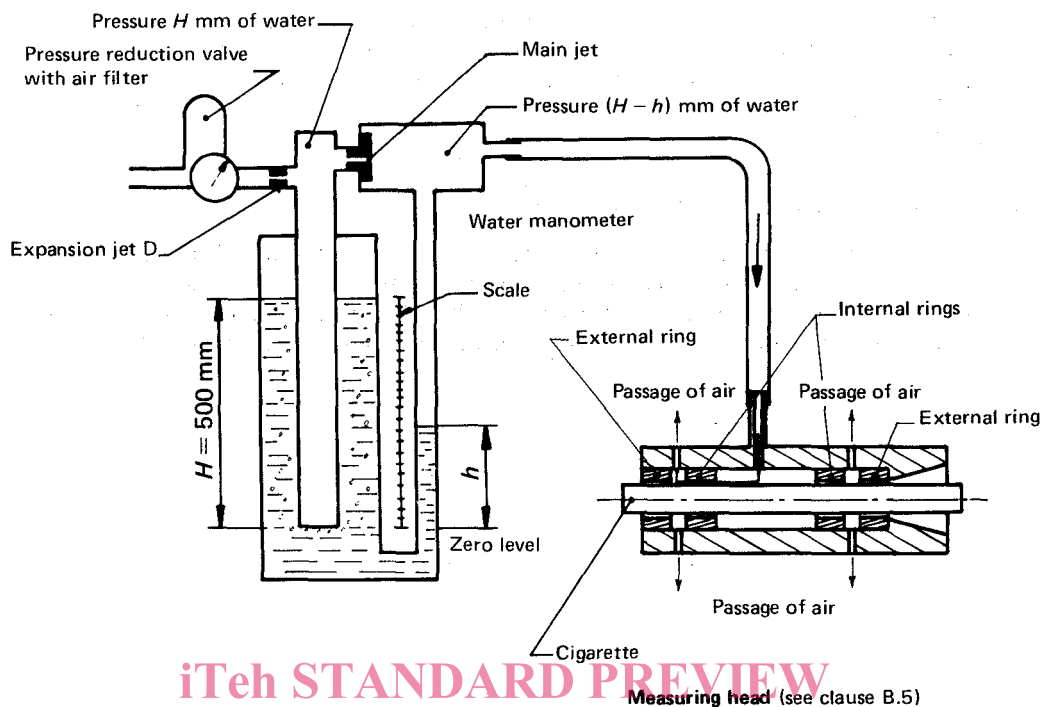
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B.2 EXAMPLE OF THE POSSIBLE SCALE RANGES FOR MEASURING HEADS

Nominal diameter ( $D_n$ )	Range in normal use (high accuracy of measurement)
mm	mm
Continuous range of values (with overlapping of individual ranges)	
7,2	6,80 to 7,30
7,5	7,20 to 7,65
7,8	7,50 to 7,95
8,0	7,90 to 8,20
8,2	8,10 to 8,40
8,4	8,30 to 8,60
8,65	8,45 to 8,75
8,80	8,60 to 8,90
9,0	8,70 to 9,20
Example of isolated values out of the normal range	
9,5	9,25 to 9,70
10,5	10,30 to 10,70

## B.3 DIAGRAM SHOWING A TYPICAL MICROMEASURER AND MEASURING HEAD ASSEMBLY



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A diagram of a typical instrument based on the principles described in clause B.1 is shown above. This uses an expansion jet D to attenuate sharp variations in the supply pressure and a main jet and a water column to provide air at a controlled pressure through a main jet to the measuring head. The pressure loss due to leakage of air between the test piece and the measuring rings is indicated on an integral water manometer.

However, any apparatus that is capable of supplying air at a controlled pressure through the main jet to the measuring head (for example by precision pressure regulators) may be used. The differential pressure between the air downstream of the main jet and that downstream of the measuring head may be measured by a separate manometer.

For the apparatus shown above, the following items are required :

- compressed air inlet;
- pressure reduction valve with air filter (clean air at low pressure);
- expansion jet D;
- pressure regulator;
- main jet;
- water manometer;
- measuring head as described in clause B.5.

On other types of apparatus, all of the parts except the main jet and measuring head may be replaced by alternative parts capable of providing the same accuracy of measurement.

#### B.4 NOTE CONCERNING THE MAIN JET

It is recommended that a main jet of 951 cm<sup>3</sup>\* be used, as the flow rate supplied should lie within a certain range which is compatible, in particular, with the desired range of the measuring scale and the required precision of the reading. However, it is clear that if the jet used does not read exactly 951, for example if it reads 940 or even 900, this will have no importance for the precision of the measurement itself. In other words, the value 951 is given as an indication. There would be no theoretical disadvantage in using a jet with another nominal value, provided that the calibration of the apparatus is carried out according to the recommended procedure.

#### B.5 SUMMARIZED DESCRIPTION OF A MEASURING HEAD

The measuring head consists of a cylindrical hollow brass frame resting on a removable base. Inside this frame are fixed four special ground steel rings which have been accurately calibrated: two internal rings known as "measuring rings", two external rings known as "centering rings" (the diameter of the external rings is 0,05 mm less than the diameter of the measuring rings). The air coming from the micromeriser passes between the measuring rings and the centering rings.

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\* Customary denomination to characterize jets.