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## Respiratory protective devices — Methods of test and test equipment —

Part 5:

### Breathing machine/metabolic simulator/RPD headforms/torso, tools and verification tools

*Appareils de protection respiratoire — Méthodes d'essai et équipement d'essai —*

*Partie 5: Machine respiratoire/simulateur métabolique/têtes factices et torses des APR/outils et outils de vérification*

ICS: 13.340.30

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ISO copyright office  
Ch. de Blandonnet 8 • CP 401  
CH-1214 Vernier, Geneva, Switzerland  
Tel. +41 22 749 01 11  
Fax +41 22 749 09 47  
copyright@iso.org  
www.iso.org

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. [www.iso.org/directives](http://www.iso.org/directives)

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The committee responsible for this document is ISO/TC 94/SC 15.

ISO 16900 consists of the following parts, under the general title *Respiratory protective devices — Methods of test and test equipment*:

- *Part 1: Determination of inward leakage*
- *Part 2: Determination of breathing resistance*
- *Part 3: Determination of particle filter penetration*
- *Part 4: Determination of gas filter capacity and migration, desorption and carbon monoxide dynamic testing*
- *Part 5: Breathing machine/metabolic simulator/RPD head forms/torso, tools and verification tools*
- *Part 6: Mechanical Resistance – Strength of Components*
- *Part 7: Practical performance tests*
- *Part 8: Measurement of airflow*
- *Part 9: Carbon dioxide content of the inhaled air*
- *Part 10: Resistance to heat, ignition and flame*
- *Part 11: Determination of field of vision*
- *Part 12: Determination of volume-averaged work of breathing and peak respiratory pressures*

- *Part 13: RPD using regenerated breathable gas and special application mining escape RPD; Consolidated test for gas concentration, temperature, humidity, work of breathing, breathing resistance and duration*
- *Part 14: Measurement of sound level*

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# Respiratory protective devices — Methods of test and test equipment — Part 5: Breathing machine, metabolic simulator, RPD head forms and torso, tools and verification tools

## 1 Scope

This part of ISO 16900 specifies the characteristics of breathing machines, metabolic simulators, RPD head forms/torso, RPD verification tools and RPD tools that are common to RPD test laboratories. Standardization of these items is essential for the standardization of the test methods.

Standardization of the RPD verification tools is essential for demonstrating the delivery of comparable results in different test laboratories.

Descriptions on the use of the RPD tools for the different tests are specified in the relevant parts of ISO 16900.

## 2 Normative references

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

ISO 16972, *Respiratory protective devices — Terms, definitions, graphical symbols and units of measurement*

ISO/TS 16976-2, *Respiratory Protective Devices — Human Factors — Part 2: Anthropometrics*

ISO 17420-3, *Respiratory protective devices — Performance requirements — Part 3: Thread connection*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 16972 and the following apply.

### 3.1

#### RPD head form

laboratory test head simulating human heads used in testing RPD

### 3.2

#### RPD torso

generic body form used in combination with a RPD head form used in testing RPD

### 3.3

#### Trachea tube assembly

tube that simulates the human trachea, containing ports for the measurement of pressure, carbon dioxide content and temperature of breathed air, and interface connections permitting seating to the RPD head form, RPD torso or alternative (benchtop) fixture

### 3.4

#### RPD head form assembly

RPD head form with trachea tube assembly included

**3.5 Breathing machine assembly**  
breathing machine plus all connecting tubes, control valves and other necessary hardware leading to the trachea tube assembly

**3.6 Metabolic simulator assembly**  
metabolic simulator plus all connecting tubes, control valves and other necessary hardware leading to the trachea tube assembly

**3.7 RPD verification tool**  
test device that simulates specific performance characteristic(s) of a respiratory protective device; the theoretical results from the test device are known, and are compared with the actual results obtained in a given test laboratory when the test device is used with the appropriate test system in that laboratory

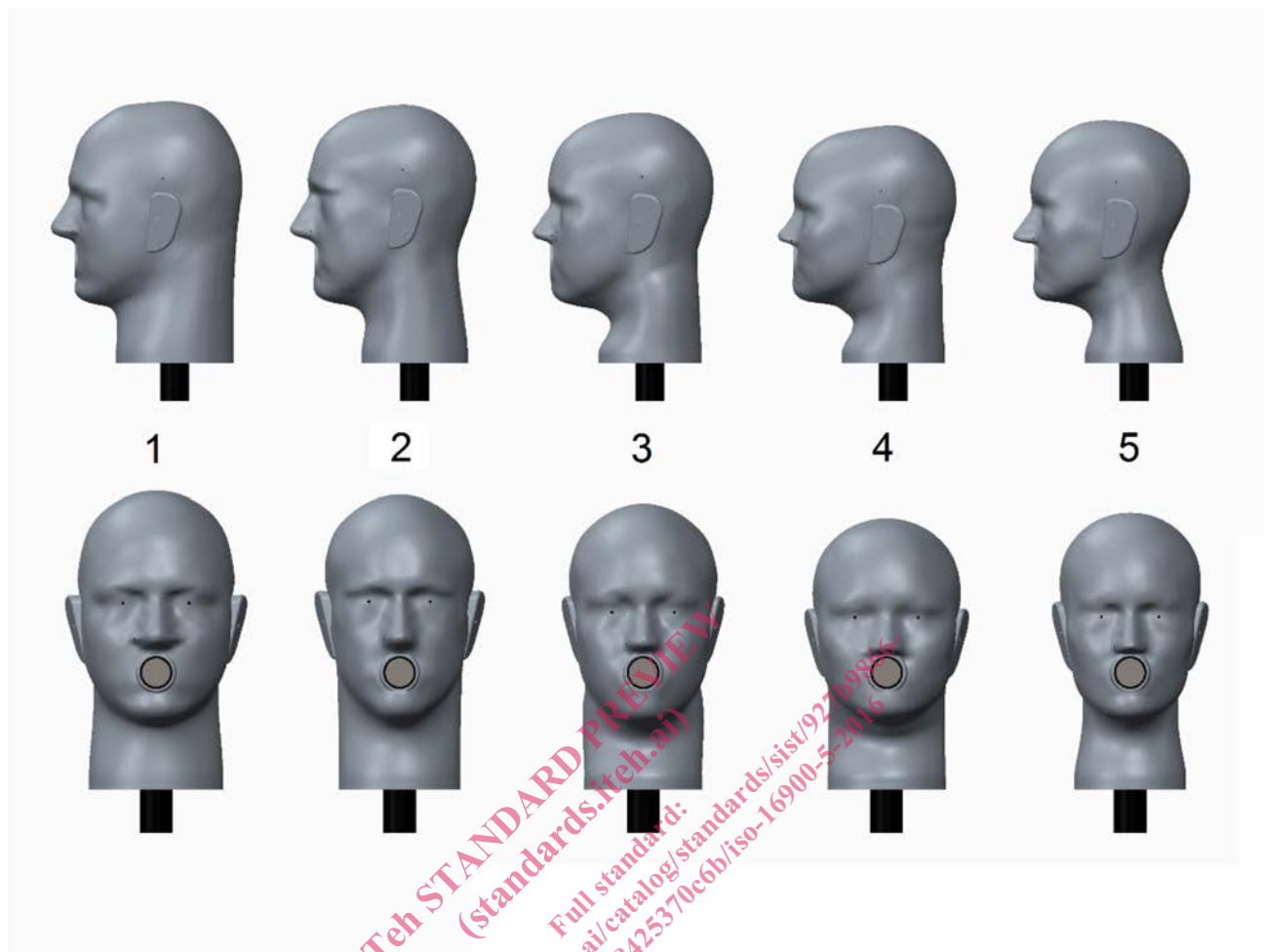
**3.8 RPD tool**  
device that assists with the testing of RPD

## 4 Description of test equipment

### 4.1 RPD head forms

The five RPD head forms used for laboratory testing are based on the anthropometric measurements and averaged head dimensions specified in ISO/TS 16976-2. Neck lengths are elongated and diameters sized in accordance with anthropometric data to permit the sealing of RPD interfaces with neck dams. All RPD head forms contain the same sized trachea tube assembly so that the connection between the neck and a RPD torso or alternative fixture is identical for all sizes. For the purpose of acoustic measurements, the ears are flat and the position of the microphones is marked. For the purposes of field of vision measurements the positions of the pupils are marked to permit the fixing of light sources. The RPD head forms are illustrated in Figure 1.





#### Key

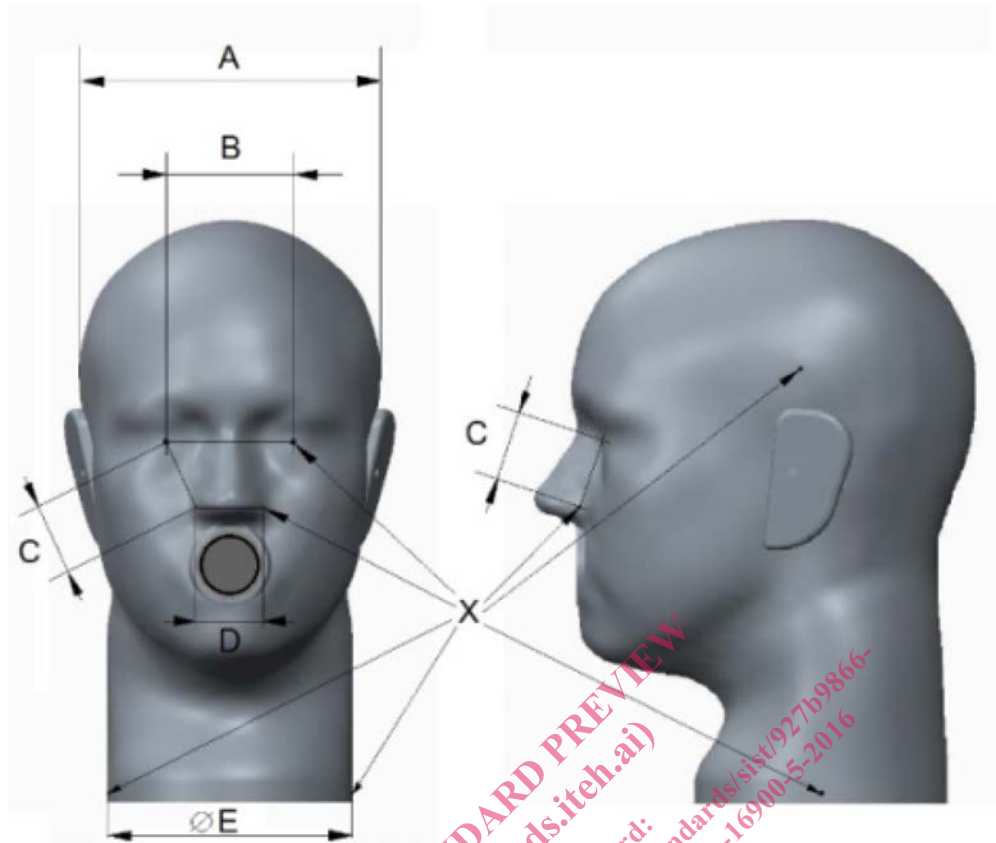
- 1 large
- 2 long/narrow
- 3 medium
- 4 short/wide
- 5 small

**Figure 1 — RPD head forms front and side view**

#### 4.1.1 RPD head form CAD files

The RPD head forms are defined by the 3-dimensional computer aided design (CAD) files derived from the dimensions specified in ISO/TS 16976-2. CAD files of the RPD head forms and are available from the source given in [2] and these will permit laboratories to produce RPD head forms of the correct dimensions.

Manufactured RPD head form size can be determined by reference to the table of reference dimensions marked by small indents, see Figure 2, index X. The reference indents are located at the left and right side of the RPD head forms, the left and right side of the nose and the centre of the pupils. The deviation of the manufactured RPD head form size from the source CAD file data shall be no more than  $\pm 1$  mm in any dimension.



Dimension in millimetres

Head form (see Figure 1)	A <sup>a</sup>	B	C <sup>a</sup>	D	E
	All dimensions are subject to a tolerance of $\pm 1$				
1	161	68	40	42	138
2	153	63	43	35	125
3	152	64	37	36	121
4	152	65	39	39	121
5	144	59	36	32	115

<sup>a</sup> These dimensions are for verification of head size only and are not the same as the anthropometric dimensions given in ISO 16976-2

**Key**

- A Maximum head width
- B Interpupillary distance
- C Eye to nose diagonal
- D Nose breadth
- E Neck diameter in cylindrical section
- X Examples of reference indent

**Figure 2 — Positions of the reference dimensions used to verify the RPD head form sizes**

#### 4.1.2 Surface finish and materials of construction

The surface finish of the RPD head forms shall be smooth and can be hard or soft. A soft surface finish shall have a hardness between 10 Shore A and 30 Shore A. The general materials of construction of the head are not specified. Irrespective of the surface finish of the RPD head form, the dimensions defined by the CAD file [2] shall be met.

The materials of construction for the RPD head form for the flame and thermal exposure tests shall be metal, ceramic or other heat-tolerant material and the surface finish shall be smooth.

#### 4.1.3 Trachea tube assembly and interface connections

The trachea tube assembly fits to all five RPD head forms. The trachea tube component shall be manufactured from stainless steel and may be designed so that it is inserted into all RPD head forms via the neck opening. The connection between the mouth opening and the trachea tube assembly shall be sealed. The connection between the RPD head form and RPD torso or alternative fixture is achieved using a mechanical socket –see Figure 3, Figure 4 and Figure 5.

The volume of the trachea tube assembly and connecting tubes within the RPD head form and RPD torso or alternative fixture, up to the position of the control valves shall be  $(500 \pm 150)$  ml. Figure 3 shows the trachea tube assembly inside the RPD head form 1 positioned on an alternative fixture. Figure 4 shows an overlay of all RPD head form sizes mounted on the RPD torso to demonstrate how the trachea tube assembly is positioned inside the RPD head forms.



a) RPD head form 1 with inserted trachea tube and control valve connection fixed positioned on alternative fixture

b) Overlay of all RPD head forms 1 to 5 positioned on alternative fixture

Figure 3 — Trachea tube assembly inside RPD head form(s) positioned on an alternative fixture.