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

**Part 5:  
Breathing machine, metabolic  
simulator, RPD headforms and torso,  
tools and verification tools**

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*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*  
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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 (see [www.iso.org/directives](http://www.iso.org/directives)).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

The committee responsible for this document is ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 15, *Respiratory protective devices*.

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 and torso, tools and verification tools*
- *Part 6: Mechanical resistance/strength of components and connections*
- *Part 7: Practical performance test methods*
- *Part 8: Measurement of RPD air flow rates of assisted filtering RPD*
- *Part 9: Determination of carbon dioxide content of the inhaled gas*
- *Part 10: Resistance to ignition, flame, radiant heat and heat*
- *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, elastance 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 headforms 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 tools and RPD verification 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.

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## 2 Normative references (standards.iteh.ai)

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 16900-9:2015, *Respiratory protective devices — Methods of test and test equipment — Part 9: Determination of carbon dioxide content of the inhaled gas*

ISO 16900-12:2016, *Respiratory protective devices — Methods of test and test equipment — Part 12: Determination of volume-averaged work of breathing and peak respiratory pressures*

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

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

ISO/TS 16976-2, *Respiratory protective devices — Human factors — Part 2: Anthropometrics*

## 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 an 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 breathable gas, 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

Note 1 to entry: 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 [ISO 16900-5:2016](https://standards.iteh.ai/catalog/standards/sist/927b9866-1f32-42d5-9b1d-848425370c6b/iso-16900-5-2016)  
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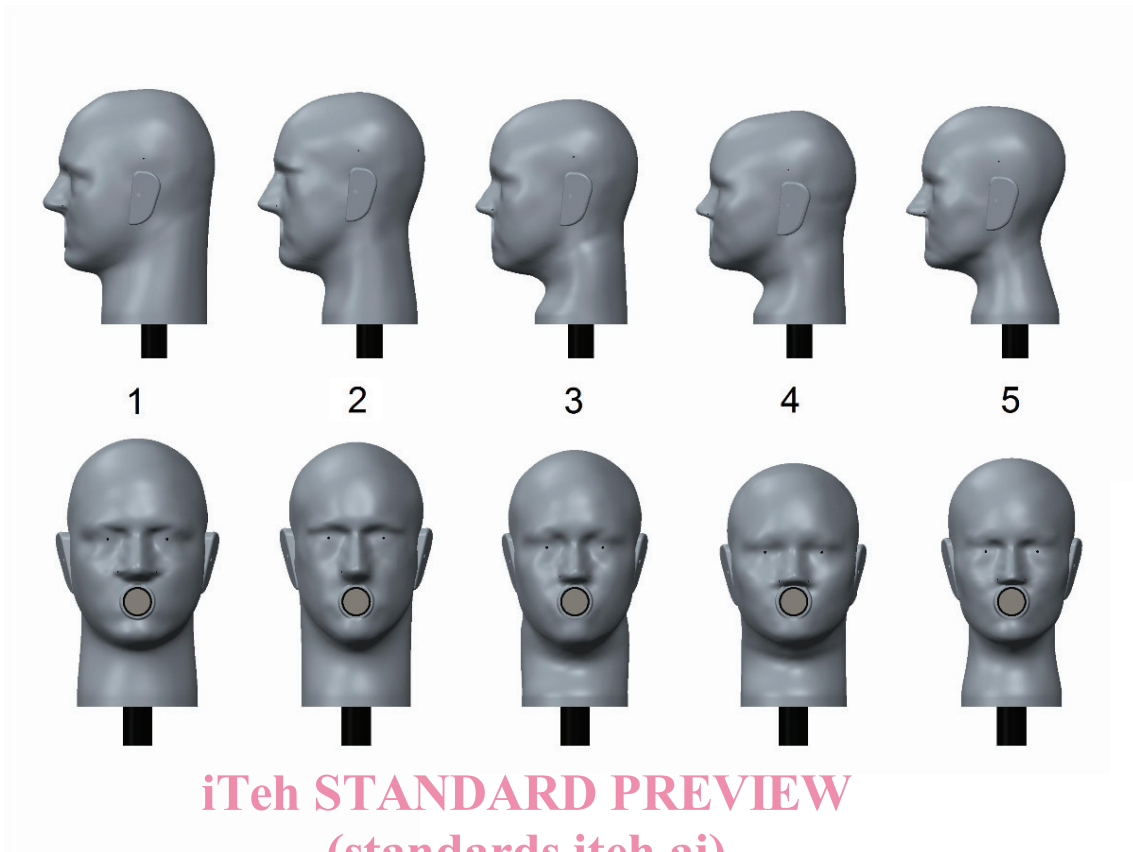
## 4 Description of test equipment

### 4.1 RPD head forms

#### 4.1.1 General

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 are 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 an 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

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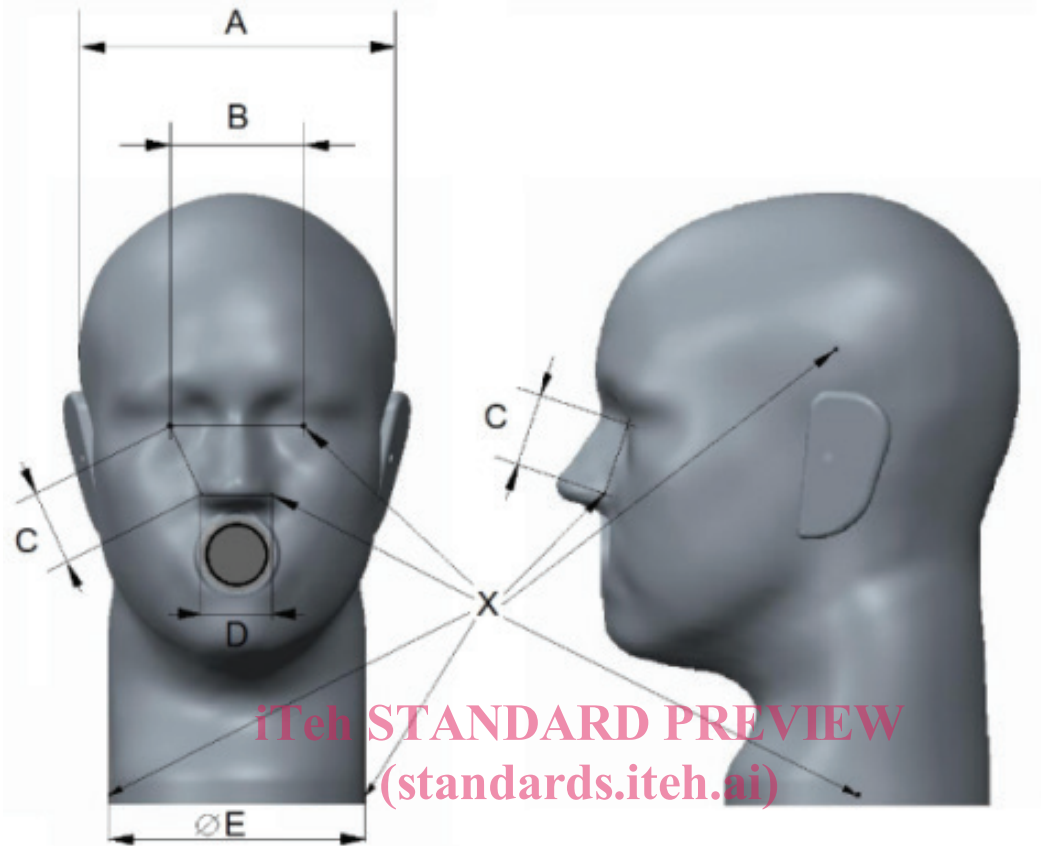
**Figure 1 — RPD head forms front and side view**

#### 4.1.2 RPD head form CAD files

The RPD head forms are defined by the three-dimensional computer-aided design (CAD) files derived from the dimensions specified in ISO/TS 16976-2. CAD files of the RPD head forms are available from the source given in Reference [3] and these will permit the production of RPD head forms of the correct dimensions. The CAD files represent the final surface geometry of the RPD head forms 1 to 5.

Each manufactured RPD head form shall be marked on the top or the back of the head with the head form number consistent with key in [Figure 1](#).

The conformance of the manufactured RPD head forms to the CAD file can be determined by reference to the table of reference dimensions marked by small indents, contained in the CAD files, see [Figure 2](#), key 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 from the source CAD file data shall be no more than  $\pm 1$  mm in any of the referenced dimension.



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Head form (see Figure 1)	A <sup>a</sup>	B	C <sup>a</sup>	D	E
	All dimensions are subject to a tolerance of ±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 interpupilliary 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**

**4.1.3 Surface finish and materials of construction**

The general materials of construction of the RPD head form are not specified, but are related to the test method in which the RPD head form is used. 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.

The hardness of a hard surface finish RPD head form is determined by the material of construction. Irrespective of the surface finish of the RPD head form, the dimensions defined by the CAD file (see Reference [3] and Figures 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.

#### 4.1.4 Trachea tube assembly and interface connections

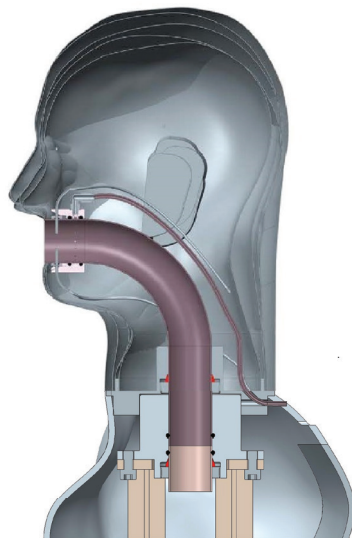
The same trachea tube assembly is used in all five RPD head forms. The trachea tube component shall be manufactured from stainless steel. The trachea tube assembly may be designed so that it can be inserted into hollow RPD head forms via the neck opening or be manufactured such that all components of the trachea tube assembly are permanently fixed. 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 Figures 3 to 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 a) shows the trachea tube assembly inside the RPD head form 1 positioned on an alternative fixture. Figure 3 b) shows an overlay of all RPD head forms 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 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



**Figure 4 — Overlay of RPD head forms 1 to 5 positioned on RPD torso illustrating single size of trachea tube assembly in RPD head forms**

The dimensions of the trachea tube assembly, interface and interface socket for RPD torso or alternative fixture are given in [Figure 5](#).

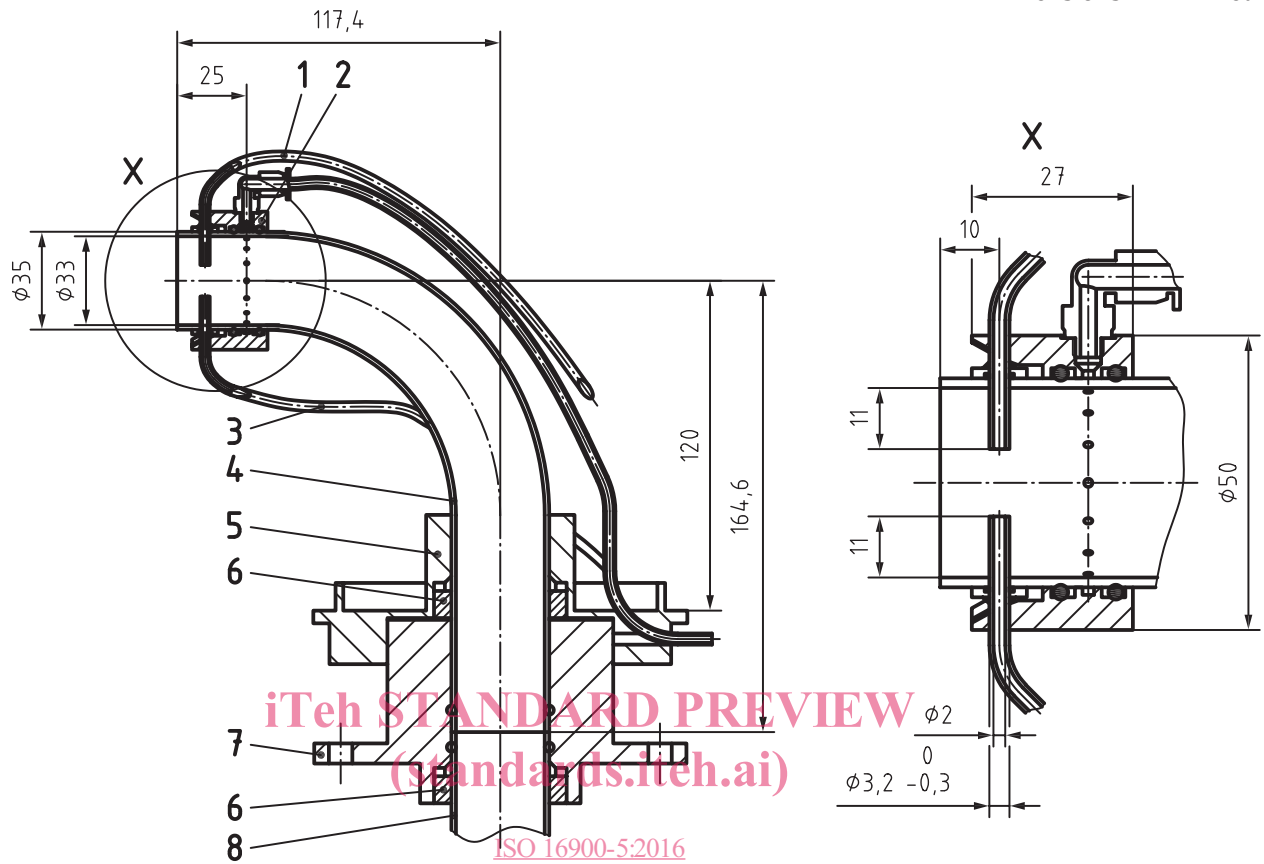
The dimensions of the stainless steel trachea tube showing the drilled holes for the pressure pickup ring (pitot ring) are given in [Figure 6](#). It is deliberate that there are no holes drilled vertically top and bottom. The holes are eliminated to prevent the possibility of liquid entering the pickup ring assembly.

The dimensions of the pressure pickup ring sampling port assembly are shown in [Figure 7](#).

The dimensions of the sample tubes, either for temperature measurement by insertion of a temperature sensor or for CO<sub>2</sub> sampling, are shown in [Figure 8](#).

**NOTE** It is intended that when using breath-by-breath CO<sub>2</sub> analysis technique (ISO 16900-9, Method 3), a narrow bore capillary tube is inserted into the CO<sub>2</sub> sample tube (item C in [Figure 5](#)) to ensure rapid transfer of the breathed air sample to the fast response CO<sub>2</sub> analyser.

Dimensions in millimetres

**Key**

- 1 temperature measuring port
- 2 pressure sampling port (pitot ring positioned over 14 holes, with a diameter of 1 mm each, equally distributed over tube cross section, excluding vertically top and bottom)
- 3 CO<sub>2</sub> sampling tube
- 4 trachea tube
- 5 RPD head form fixture
- 6 interface screw thread
- 7 RPD head form interface to RPD torso or alternative fixture
- 8 connection to control valves

NOTE Tolerances in accordance with ISO 2768-m.

**Figure 5 — Dimensions of the trachea tube assembly, interface and interface socket**