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Respiratory protective devices — Methods of test and test equipment —

Part 8: Measurement of RPD air flow rates of assisted filtering RPD

Appareils de protection respiratoire — Méthodes d'essai et équipement d'essai —
Partie 8: Mesurage des débit d'air des APR filtrants à ventilation assistée

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Contents

Page

Foreword

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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).

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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 WTO principles in the Technical Barriers to Trade (TBT), see the following URL: Foreword — Supplementary information.

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 headforms/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: Carbon dioxide content of the inhaled air*

— *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*

Introduction

This part of ISO 16900 is intended as a supplement to the respiratory protective devices (RPD) performance standards. Test methods are specified for complete devices or parts of devices that are intended to comply with the performance standards. If deviations from the test method given in this part of ISO 16900 are necessary, these deviations will be specified in the performance standards.

Respiratory protective devices — Methods of test and test equipment —

Part 8: Measurement of RPD air flow rates of assisted filtering RPD

1 Scope

This part of ISO 16900 specifies the methods for measuring air flow rates delivered to the wearer by an assisted filtering RPD.

2 Normative references

The following referenced documents, in whole or in parts, 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 16972, *Respiratory protective devices — Terms, definitions, graphical symbols and units of measurement*

3 Terms and definitions

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

NOTE Within the definitions listed in 3.2 to 3.7, the flow rates are deemed to be volumetric flow rates.

3.1
assisted filtering RPD
filtering RPD where breathable gas is actively supplied to the wearer by the RPD

3.2
interactive flow rate
flow rate through the filters of an *assisted filtering RPD* (3.1) resulting from the combined action of the assisted filtering RPD and the breathing pattern generated by the breathing machine

3.3
averaged interactive flow rate
interactive flow rate averaged over 10 consecutive breathing cycles of the breathing machine

3.4
averaged maximum interactive flow rate
average of the highest flow rate within each breathing cycle of 10 consecutive breathing cycles of the breathing machine

3.5
averaged minimum interactive flow rate
average of the lowest flow rate within each breathing cycle of 10 consecutive breathing cycles of the breathing machine

3.6
measured maximum flow rate
volumetric flow rate of an *assisted filtering RPD* (3.1), determined in a laboratory test, when the RPD is in the condition which results in the highest air flow rate, where this condition takes into account the influences of temperatures, settings of RPD, pre-conditionings, use of accessories and others

3.7
measured minimum flow rate
volumetric flow rate of an *assisted filtering RPD* (3.1), determined in a laboratory test, when the RPD is in the condition which results in the lowest air flow rate, where this condition takes into account the influences of temperatures, settings of RPD, pre-conditionings, use of accessories, and others

4 Prerequisites

In order to implement this part of ISO 16900, at least the following parameters need to be specified in the relevant performance standard:

a) number of test specimens;

b) operating conditions of the RPD, e.g. possible air flow settings, charging status of batteries, influences from the temperature of operation;

c) designated operational temperature range;

d) appropriate RPD headform(s) and, if necessary, torso;

e) any pre-conditioning.

5 General test requirements

Unless otherwise specified, the values stated in this International Standard are expressed as nominal values. Except for temperature limits, values which are not stated as maxima or minima shall be subject to a tolerance of ±5 %. Unless otherwise specified, the ambient conditions for testing shall be between 16 °C and 32 °C and (50 ± 30) % RH. Any temperature limits specified shall be subject to an accuracy of ±1 °C.

Where the assessment of the pass/fail criterion depends on a measurement, an uncertainty of measurement as specified in Annex A shall be given.

6 Principle

The complete RPD is fitted to an appropriate headform and, if necessary, torso and the RPD operated in accordance with the manufacturer's instructions for use, unless prescribed otherwise by the performance standard. The air flow supplied by the RPD is measured as the air flow rate.

Depending on the prerequisites given it might be required to determine the air flow rate at conditions which result in the minimum flow rate or the maximum flow rate of the RPD. Depending on the design of the RPD, these air flow rates may be determined by possible flow settings of the RPD, initialization time, the charging status of the battery, different filter types, alarm settings, the temperature of the RPD, including the temperature range for use, use of accessories, hose length, supply pressure, and other factors.

Where it is necessary to manipulate the RPD in order to achieve, during subsequent tests, a constant flow equivalent to either the measured maximum or minimum flow, the procedure that has to be adopted will depend on the design of the RPD. Possible ways of achieving such adjustments are substituting the battery by an external variable controlled power supply, artificially increasing the pressure drop of the filters used, or artificially adjusting the air flow control system of the RPD.

All results of measured air flow rates are deemed to be volumetric flow rates and shall be corrected to 20°C, 1013 hPa according to Formula (1)

$$Q_{cor} = Q_m \cdot k \cdot \left(\frac{P_m}{T_m} \right) \quad (1)$$

where

Q_{cor} is the corrected air flow;

Q_m is the measured air flow;

k is a constant 0,289 [K/hPa], i.e. 293 K divided by 1,013 hPa (20°C);

P_m is the pressure during measurement in hPa;

T_m is the temperature during measurement in K.

7 Test method

7.1 General

This part of ISO 16900 describes two test methods: measurement of flow rate using zero back pressure method and measurement of the interactive flow rate.

7.2 Measurement of flow rate using zero back pressure method

7.2.1 General

This test is suitable for RPD, where the interactive flow rate is constant, e.g. RPD with Respiratory Interface class L (loose fitting).

7.2.2 Test equipment

The test equipment consists of the following:

— appropriate **RPD headform**, of the appropriate size;

— **torso**, where necessary;

— **blower** or **suction device** with the air flow capacity to blow or draw an appropriate amount of air. The required air flow capacity shall be greater than the maximum airflow supplied by the RPD under test. The capacity usually needs to be above the flow rate which corresponds to the peak flow rate of the designated work rate class of the device. The air flow rate of the blower or suction device shall be controllable;

— **suitable flow meter**, calibrated in the range of air flow to be measured;

— **differential pressure sensor**, with a precision of better than ±5 Pa at 0 Pa;

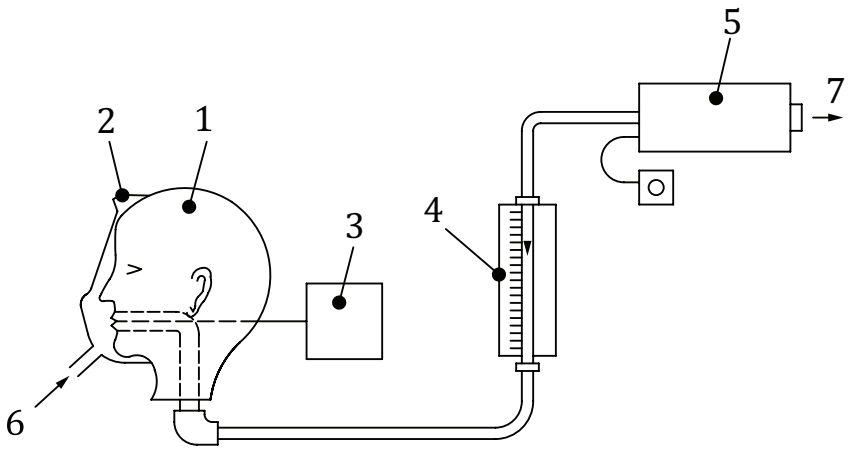
— **airtight box** or **lightweight bag** of a volume between 10 l and 30 l with necessary airtight connections.

7.2.3 Test procedure for RPD with a respiratory interface class T

The respiratory interface shall be fitted to the appropriate headform and, if necessary, a torso. Respiratory interfaces of class T shall be fitted in a leaktight manner to the headform. A sealant might

be necessary for this. The differential pressure sensor, the flow meter, and the suction device shall be arranged as shown in Figure 1.

The RPD shall be activated. The controllable suction device of the test equipment used to draw air from the mouth opening of the head form shall be switched on and adjusted such that the differential pressure sensor shows a constant value of 0 ± 5 Pa, when compared to the ambient pressure. The air flow rate measured by the flow meter is the average interactive flow rate.



Key

1	headform	5	controllable suction device
2	respiratory interface class T	6	air flow of the RPD
3	differential pressure sensor	7	air flow from controllable suction device
4	air flow meter		

Figure 1 — Typical test arrangement for air flow rate measurement of RPD with Respiratory Interface of class T

7.2.4 Test procedure for RPD with a respiratory interface class L

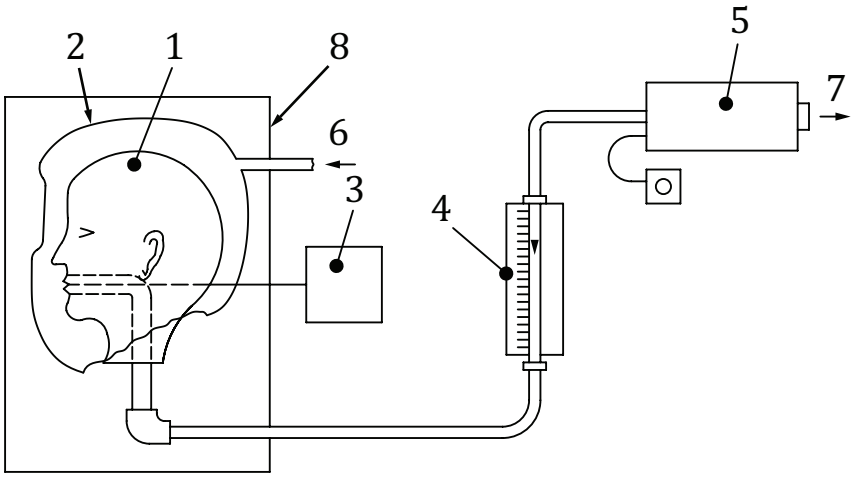
The loose fitting respiratory interface shall be fitted to the appropriate headform and, if necessary, a torso. The differential pressure sensor, flow meter, the blower, and the box or lightweight bag shall be arranged as shown in Figure 2 or Figure 3. All connections to and from the box or lightweight bag shall be leak tight.

For RPD with a Respiratory Interface of class L, Figure 2 shows an appropriate test setup.

For RPD where the blower of the RPD is integrated in the Respiratory Interface of class L, Figure 3 shows an appropriate test setup.

The RPD shall be activated. The adjustable blower device of the test equipment shall be switched on and adjusted so that the lightweight bag does not inflate, nor deflate. A pressure sensor might be helpful to find the exact adjustment of the blower.

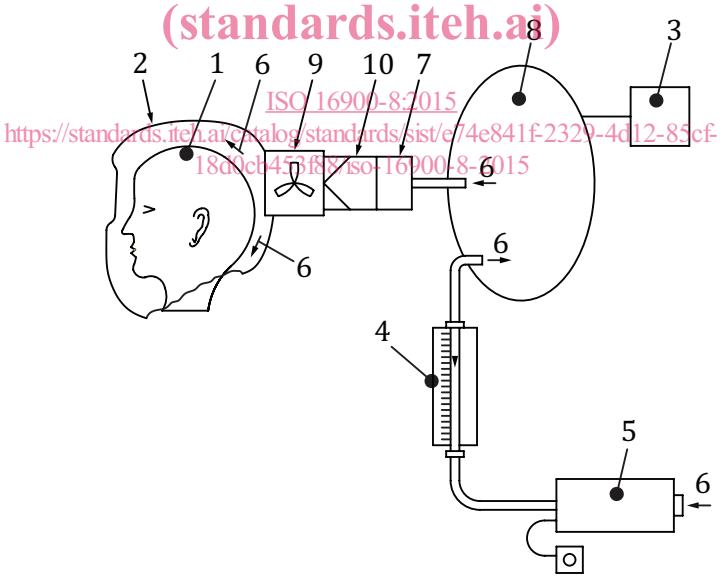
If a box is used, the blower device shall be adjusted such that the pressure sensor shows a constant value of (0 ± 5) Pa when compared to the ambient pressure. The air flow rate measured by the flow meter is the averaged interactive flow rate.



Key

1	headform	5	controllable suction device
2	respiratory interface class L	6	air flow supplied by the RPD
3	differential pressure sensor	7	air flow from controllable suction device
4	air flow meter	8	box or lightweight bag, either may be used

Figure 2 — Typical test arrangement for air flow rate measurement of RPD with Respiratory Interface class L where the air flow to the respiratory interface is supplied via a hose



Key

1	headform	6	air flow
2	respiratory interface class L	7	leak tight connector between filter and breathing bag or box
3	differential pressure sensor	8	box or lightweight bag
4	air flow meter	9	blower of RPD
5	controllable blower	10	filter of RPD

Figure 3 — Typical test arrangement for air flow rate measurement of RPD, where the blower of the RPD is integrated in the Respiratory Interface class L