BS ISO 17420-2:2021

BSI Standards Publication

Respiratory protective devices — Performance requirements

Part 2: Requirements for filtering RPD

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee PH/4, Respiratory protection.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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Part 2: Requirements for filtering RPD

Appareils de protection respiratoire — Exigences de performances — Partie 2: Dispositifs de filtration

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Contents

Page

Foreword ... **v**

Introduction ... **vi**

1 Scope ... **1**

2 Normative references ... **1**

3 Terms, definitions, abbreviations and symbols ... **2**
3.1 Terms and definitions ... 2
3.2 Abbreviated terms ... 3
3.3 Symbols ... 4

4 Classification overview ... **5**

5 General requirements for RPD ... **6**
5.1 General ... 6
5.2 Field of vision ... 6
5.3 Resistance to flame – Single burner dynamic ... 6
5.4 Compatibility with additional equipment ... 6
5.5 Monitor performance ... 6
5.6 Warning device(s), checking device(s) and control means ... 6
5.6.1 Performance of warning device(s), if applicable ... 6
5.6.2 Performance of checking device ... 7
5.6.3 Control means (if applicable) ... 7
5.7 Protection class determination ... 7
5.7.1 General ... 7
5.7.2 Total inward leakage (TIL) ... 7
5.7.3 Total inward leakage requirement for RPD not using a standardized connector ... 7
5.8 Validation by practical performance ... 8
5.8.1 General ... 8
5.8.2 Donning/doffing ... 8
5.8.3 Communication performance - hearing and speech ... 8
5.8.4 Eye irritation caused by the RPD ... 8
5.8.5 Fogging of visor ... 8
5.8.6 Ergonomic requirements ... 8
5.9 Requirements for elements/components ... 8

6 Requirements for filtering RPD ... **8**
6.1 Determination of air flow rate of assisted RPD ... 8
6.2 Determination of the effect of temperature on flow rates for assisted RPD ... 9
6.3 Work of breathing, breathing resistance (peak pressure) and elastance ... 9
6.3.1 Work of breathing, breathing resistance (peak pressure) and elastance for unassisted RPD ... 9
6.3.2 Work of breathing, breathing resistance (peak pressure) and elastance for assisted RPD ... 10
6.4 CO_2 concentration limits ... 12
6.4.1 CO_2 concentration limits for assisted RPD ... 12
6.4.2 CO_2 concentration limits of unassisted RPD ... 12
6.4.3 CO_2 concentration limits for RI with standardized connector ... 12
6.5 Noise limit for assisted RPD ... 13
6.6 Temperature and humidity of inhaled air for RPD which protect against CO ... 13
6.7 Connections ... 13
6.7.1 General ... 13
6.7.2 Strength of connections – Connections to RI ... 14
6.7.3 Low pressure connections other than to the RI ... 16
6.8 Assessment of reliability ... 17
6.9 Pre-conditioning (Sequential/Non-sequential) ... 17
6.9.1 General ... 17

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AVA Documents
Document Sharing Hub

Full document details: BS ISO 17420-2:2021

6.9.2 Sequential pre-conditioning 18
6.9.3 Non-sequential pre-conditioning 19
6.10 Requirements for elements/components 19
6.10.1 Filters 19
6.10.2 Flexibility and resistance to deformation of hoses 30
6.11 Requirements for RPD with standardized connector 31
6.11.1 General 31
6.11.2 Filters with standardized connector 31
6.11.3 RI with standardized connector 33
6.11.4 Protection class determination for RPD using standardized connector 34
6.11.5 RPD using standardized connector and low pressure hoses 34
6.12 Multi-functional RPD 35
6.13 Requirements for optional features 35
6.13.1 General 35
6.13.2 Extreme low temperature requirements 35
6.13.3 Extreme high temperature requirements 36
6.13.4 Contact with hot surface 36
6.13.5 Hydration 36
6.13.6 Performance of RPD using prefilters 37
6.13.7 Use of RPD in potentially explosive atmospheres 37
6.13.8 Electromagnetic compatibility of RPD 37

7 Testing 37
7.1 General 37
7.2 Inspection 37
7.3 Testing of leak tightness using positive pressure 38
7.4 Contact with hot surface 38

8 Marking 38
8.1 General 38
8.2 Marking of RPD without separable components 38
8.3 Marking of RPD replacement parts 39
8.4 Marking of RPD components as part of a system 39
8.4.1 RI 39
8.4.2 Marking of particle, gas/vapour or combination filters 40
8.4.3 Other separable components 40

9 Information supplied by the RPD manufacturer 41
9.1 General 41
9.2 RPD 41
9.2.1 Minimum information 41
9.2.2 Additional information 42
9.3 RPD components and replacement parts 42
9.3.1 Particle, gas/vapour or combination filters 42
9.3.2 RI 43
9.3.3 Other components or replacement parts 44

Annex A (informative) **Reliability 45**

Annex B (informative) **Example of failure modes and effect analysis (FMEA) 47**

Annex C (normative) **Test schedules 51**

Annex D (normative) **Normalisation of test results 74**

Bibliography 76

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Document Sharing Hub
Full document details: BS ISO 17420-2:2021

Foreword

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This document was prepared by Technical Committee ISO/TC 94, *Personal safety - Personal protective equipment*, Subcommittee SC 15, *Respiratory protective devices*.

A list of all parts in the ISO 17420 series can be found on the ISO website.

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Introduction

This document describes basic requirements for filtering respiratory protective devices (RPD) and its elements and components.

Requirements for RPD used in environments for special applications are given in the relevant parts of the ISO 17420 series.

Some test methods are described. For other test methods references are given to the ISO 16900 series "Methods of test and test equipment" or other test methods not developed by ISO/TC 94/SC 15.

Annex A gives information about reliability.

Annex B features an example of a FMEA (Failure Mode and Effects Analysis).

Annex C gives the test schedules including any pre-conditioning and number of samples.

Annex D provides information for normalisation of test results.

The sequence of testing follows the principle to minimize the necessary number of samples by carrying out destructive tests at the end. It also includes for safety reason that tests with test subjects are only carried out after the test samples have shown their safe performance in other tests.

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Respiratory protective devices — Performance requirements —

Part 2: Requirements for filtering RPD

1 Scope

This document specifies requirements for the performance and testing of filtering respiratory protective devices (RPD) in accordance with their classification and for use in the workplace to protect the wearer from hazardous atmospheres and/or environments.

Requirements for RPD elements and components are also specified in this document.

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 9227, *Corrosion tests in artificial atmospheres — Salt spray tests*

ISO 16900-1:2019, *Respiratory protective devices — Methods of test and test equipment — Part 1: Determination of inward leakage*

ISO 16900-2, *Respiratory protective devices — Methods of test and test equipment — Part 2: Determination of breathing resistance*

ISO 16900-3, *Respiratory protective devices — Methods of test and test equipment — Part 3: Determination of particle filter penetration*

ISO 16900-4:2011, *Respiratory protective devices — Methods of test and test equipment — Part 4: Determination of gas filter capacity and migration, desorption and carbon monoxide dynamic testing*

ISO 16900-5, *Respiratory protective devices — Methods of test and test equipment — Part 5: Breathing machine, metabolic simulator, RPD headforms and torso, tools and verification tools*

ISO 16900-6:—[1], *Respiratory protective devices — Methods of test and test equipment — Part 6: Mechanical resistance/strength of components and connections*

ISO 16900-7:2020, *Respiratory protective devices — Methods of test and test equipment — Part 7: Practical performance test methods*

ISO 16900-8, *Respiratory protective devices — Methods of test and test equipment — Part 8: Measurement of RPD air flow rates of assisted filtering RPD*

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

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

1) Under preparation, Stage at the time of publication ISO/DIS 16900-6:2020.

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ISO 16900-14:2020, *Respiratory protective devices — Methods of test and test equipment — Part 14: Measurement of sound level*

ISO 16972, *Respiratory protective devices — Vocabulary and graphical symbols*

ISO/TS 16973, *Respiratory protective devices -- Classification for respiratory protective device (RPD), excluding RPD for underwater application*

ISO 17420-1:2021, *Respiratory protective devices — Performance requirements — Part 1: General*

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

IEC 61000-6-2, *Electromagnetic compatibility (EMC) — Part 6-2: Generic standards — Immunity standard for industrial environments*

3 Terms, definitions, abbreviations and symbols

3.1 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1.1
non pre-conditioned state
without pre-conditioning but possibly modified to carry out tests or already used in non-destructive tests

Note 1 to entry: This includes e.g. cleaning and disinfection.

3.1.2
as worn state
RPD where all components are connected and assembled in the way that it is intended to be used and worn (e.g. worn by the wearer, adapted to a RPD headform or RPD headform and torso or suitable holder)

Note 1 to entry: All of the various components [e.g. for an assisted filtering device: blower unit, battery, respiratory interface (RI), filters, etc.] have been completely assembled and then connected (RI connected to the hose of the blower unit) together in accordance with the information supplied by the manufacturer.

3.1.3
ready for assembly state
RPD or components with seals, plugs or other environmental protective means, still in place ready to be assembled and/or donned

Note 1 to entry: RPD or components can remain sealed and plugged until donning if so stated in the information supplied by the manufacturer.

3.1.4
integrated RPD
RPD designed so that components in the breathable gas supply chain are nonseparable

3.1.5
measured maximum flow rate
volumetric flow rate of an assisted filtering RPD, 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 any other related factors

[SOURCE: ISO 16900-8:2015, 3.6]

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3.1.6
migration
diffusion of the gas or vapour molecules within the sorbent after the filter is partially loaded

3.1.7
standardized connector
device that allows an optional connection between a filter and a respiratory interface

Note 1 to entry: Filter connector meeting the requirements of ISO 17420-3.

3.1.8
replacement part
identical to the one originally supplied with the RPD by the manufacturer, and declared interchangeable by the manufacturer

3.1.9
normalised condition
test condition adjusted to 1013 hPa and body temperature (37 °C or 310 K) saturated with water vapour, which is 63 hPa, used for the normalization of test results

Note 1 to entry: Further information is given in Annex D.

3.2 Abbreviated terms

FMEA	Failure Mode and Effects Analysis
V_T	Tidal volume
WoB	Work of Breathing
BTPS	body temperature pressure saturated

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3.3 Symbols

3.3.1

Product information; information point (ISO 7000-2760).

Indication for the RI that it is a part of a RPD system with multiple configurations.

3.3.2

Operator's manual; operating instructions (ISO 7000-1641).

Booklet: "See information supplied by the RPD manufacturer"

3.3.3

Do not re-use (ISO 7000-1051).

Crossed out 2: “For single shift use only”

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3.3.4

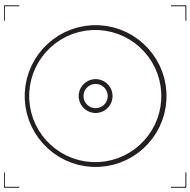
yyyy/mm

Use by date (ISO 7000-2607)

Hourglass: "End of shelf life"

Key: yyyy year, mm month

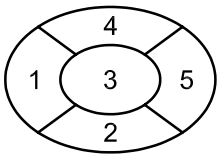
3.3.5



Roller; cylinder (ISO 7000-0566)

Target: "Standardized connector"

3.3.6



RPD headform number allocation for size designation

4 Classification overview

ISO 17420-1:2021, 4.1 applies with the following addition:

The classification of a filtering RPD is determined by the appropriate combination of the following classes: (protection class) (work rate class) (RI class) (particle filterclass and/or gas filter type and class).

Additionally filtering RPD may be classified for one or more special applications, as given in ISO 17420-5 to ISO 17420-9.

Table 1 — Gas filter type and class

Type	Class(es)	Type description
OV	1, 2, 3 or 4	Organic vapours
OG	1	Organic gases (low boiling, i.e. below 65 °C)
AC	1, 2, 3 or 4	Acidic compounds
BC	1, 2, 3 or 4	Basic compounds
NO_x	1, 2 or 3	Nitrogen oxides
HG	1, 2 or 3	Mercury (Hg)
OZ	1	Ozone (O_3)
HCN	1, 2, 3 or 4	Hydrogen Cyanide (HCN)
AH	1	Arsine (AsH_3)

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Table 1 *(continued)*

Type	Class(es)	Type description
HF	1, 2 or 3	Hydrogen fluoride (HF)
CD	1	Chlorine dioxide (ClO_2)
ETO	1, 2 or 3	Ethylene oxide ($(CH_2)_2O$)
FM	1, 2 or 3	Formaldehyde (CH_2O)
MB	1, 2 or 3	Methyl bromide (CH_3Br)
CO	Three classes based on time (20 min, 60 min or 180 min)	Carbon monoxide (CO)
PH	1 or 2	Phosphine (PH_3)

The designation of a filtering RPD is determined by an appropriate combination of the classes given in ISO 17420-1:2021, Table 1 and Table 1 of this document.

Example for a basic RPD with protection class (PC3), work rate class (W2), RI class (bT), particle filter class (F3) and gas filter type and class (OV2).

Marking for the given example PC3 W2 bT F3 OV2

Multi-functional filtering RPD have separate classifications for each function, i.e. one classification for the unassisted mode and one classification for the assisted mode.

5 General requirements for RPD

5.1 General

ISO 17420-1:2021, 5.1, applies.

5.2 Field of vision

ISO 17420-1:2021, 5.2, applies.

5.3 Resistance to flame – Single burner dynamic

ISO 17420-1:2021, 5.3, applies.

5.4 Compatibility with additional equipment

ISO 17420-1:2021, 5.4, applies.

5.5 Monitor performance

ISO 17420-1:2021, 5.5, applies with the following addition:

The monitor system shall not interfere with the operation of the RPD.

5.6 Warning device(s), checking device(s) and control means

5.6.1 Performance of warning device(s), if applicable

RPD shall be checked after sequential pre-conditioning in accordance with 6.9.2.

RPD powered by an energy source shall be equipped with a low energy warning device to warn the wearer at least 5 min prior to the performance of the RPD falling below the manufacturer's minimum design conditions. From the activation of the warning the RPD shall be tested in accordance with 6.3.2 for a period of 5 min but with a fixed setting of 35 l/min, see Table 2.

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Check in accordance with 7.2 and Clause 9.

For assisted filtering RPD a warning device shall warn the wearer when the performance of the RPD is outside of the manufacturer's design conditions.

Testing shall be performed in accordance with 6.3.2 and, if applicable, in accordance with ISO 16900-8.

During use, warning devices shall not switch off automatically and shall not be capable of being switched off by the wearer while the cause of the warning remains other than to correct the warning condition.

Check in accordance with 7.2.

Any warning shall be detectable without any intervention by the wearer. Any warning shall be detectable by the wearer within 15 s.

Testing shall be performed in accordance with ISO 16900-7:2020, Annex B, activity k).

Any warnings which require different reactions by the wearer shall be distinguishable from one another.

Check in accordance with 7.2.

5.6.2 Performance of checking device

ISO 17420-1:2021, 5.6.2, applies.

5.6.3 Control means (if applicable)

Manual control means installed on a RPD shall be clearly identifiable and, if more than one, distinguishable from one another by the wearer during use.

If there is a control means for setting different PC classes it shall not be possible to change the PC class during use without indication to the wearer.

Adjustable control means shall be tested in accordance with 6.3.

Testing shall be performed in accordance with ISO 16900-7.

5.7 Protection class determination

5.7.1 General

ISO 17420-1:2021, 5.7.1, applies.

5.7.2 Total inward leakage (TIL)

ISO 17420-1:2021, 5.7.2, applies.

The following applies in addition to ISO 17420-1:2021, 5.7.

5.7.3 Total inward leakage requirement for RPD not using a standardized connector

RPD, except those with RIs class aT, shall be tested for total inward leakage in accordance with ISO 17420-1:2021, 5.7.2.

NOTE 1 For RI using standardized connector see 6.11.3.3.

NOTE 2 For RI class a see ISO 17420-1:2021, 5.7.2.

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5.8 Validation by practical performance

5.8.1 General

ISO 17420-1:2021, 5.8.1, and the following applies:

Two RPD sequentially pre-conditioned in accordance with 6.9.2 shall undergo practical performance tests.

Prior to the practical performance testing the RPD performance shall have passed the tests according to at least the following clauses:

— 6.3 [work of breathing, breathing resistance (peak pressure) and elastance];

— 6.4 (CO_2 concentration);

— ISO 17420-1:2021, 5.9.1 (RI);

— 6.5 (noise limit for assisted RPD),

— 6.7 (connections);

— 5.6 [warning and checking device(s)].

5.8.2 Donning/doffing

ISO 17420-1:2021, 5.8.2 applies.

5.8.3 Communication performance - hearing and speech

ISO 17420-1:2021, 5.8.3 applies.

5.8.4 Eye irritation caused by the RPD

ISO 17420-1:2021, 5.8.4 applies.

5.8.5 Fogging of visor

ISO 17420-1:2021, 5.8.5 applies.

5.8.6 Ergonomic requirements

ISO 17420-1:2021, 5.8.6 applies.

5.9 Requirements for elements/components

ISO 17420-1:2021, 5.9 applies.

6 Requirements for filtering RPD

6.1 Determination of air flow rate of assisted RPD

For assisted RPD the air flow rate shall be determined at conditions which result in the minimum flow rate and the maximum flow rate of the RPD.

Depending on the design of the RPD these air flow rates can be influenced by

— possible flow settings of the RPD,

— service life,

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— 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, and

— other factors, if applicable.

— Testing shall be performed in accordance with ISO 16900-8.

6.2 Determination of the effect of temperature on flow rates for assisted RPD

To determine the influence of temperature the RPD shall be tested for flow after each of the following:

a) equilibrated for a minimum of 4 h at $\left(35^{\;0}_{-2}\right)$ °C and at a relative humidity of (50 ± 20) %

b) and equilibrated for a minimum of 4 h at $\left(-5^{+2}_{\;0}\right)$ °C.

Testing shall be started within 3 min after each equilibration at ambient laboratory conditions.

Taking into account the influencing parameters as listed in 6.1 the measured minimum and the measured maximum flow rate shall be determined in accordance with ISO 16900-8.

6.3 Work of breathing, breathing resistance (peak pressure) and elastance

6.3.1 Work of breathing, breathing resistance (peak pressure) and elastance for unassisted RPD

For filters with standardized connectors see 6.11.2.1.

For RI with standardized connectors see 6.11.3.2.

The RPD shall be tested with one of each size of the RI.

The RPD headform number(s) allocated to the RI used for the tests is/are specified by the manufacturer.

Integrated RPD or components in ready for assembly state shall be exposed to the sequential preconditioning in accordance with 6.9.2.

In addition to the sequential pre-conditioning in accordance with 6.9.2 one integrated RPD in its ready to worn state containing electronics or component(s) in its ready for assembly state containing electronics shall be exposed to the non-sequential preconditioning in accordance with 6.9.3.2. RPD shall meet the requirements set forth in Table 3 for work of breathing/breathing resistance, when tested in accordance with the settings for the breathing machine for each work rate as given in Table 2.

The temperature of operation of unassisted RPD is covered by the pre-conditioning according to 6.9.2.2 because for those types of RPD testing at the extremes gives no further information.

The work of breathing, breathing resistance (peak pressure), and elastance shall be calculated from the average pressure volume loop based on 10 consecutive breathing cycles and shall not exceed the limits given in Table 3.

The settings for the breathing machine for each work rate are given in Table 2.

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Table 2 — Setting of breathing machine at work rates for assisted and unassisted RPD

Work rate	Flow rate (dynamic sinusoidal) l/min at BTPS	Frequency cycles/min	Tidal volume l at BTPS
Resting	10 with a tolerance of ±3 %	10,0	1,0
W1	35 with a tolerance of ±2 %	23,3	1,5
W2	65 with a tolerance of ±2 %	32,5	2,0
W3	105 with a tolerance of ±2 %	42,0	2,5
W4	135 with a tolerance of ±1 %	45,0	3,0

Testing shall be performed in accordance with ISO 16900-5 and ISO 16900-12.

Tidal volumes are expressed at BTPS. In order to be able to compare the performance of different RPD the results achieved at any laboratory conditions shall be normalized to body temperature (37 °C) and normalized pressure (1 013 hPa) in accordance with Annex D.

An example for normalisation calculation for work of breathing results is given in D.2.1.

6.3.2 Work of breathing, breathing resistance (peak pressure) and elastance for assisted RPD

Integrated RPD or components in ready for assembly state shall be pre-conditioned in accordance with 6.9.2.

In addition to the sequential pre-conditioning in accordance with 6.9.2 one integrated RPD or component(s) in ready for assembly state shall be pre-conditioned in accordance with 6.9.3.2 (salt spray) as applicable, prior to validation testing.

RPD shall be set to the minimum and maximum measured flow rates determined in accordance with 6.2.

RPD shall be tested in accordance with the test regime for its work rate class as stated by the manufacturer and meet the requirements for work of breathing, breathing resistance and elastance for each flow rate as given in Table 3.

RPD work of breathing and breathing resistance (peak pressures) shall be measured in each step of the performance regime for the designated work rate class, given in Table 3. The measurements shall start after the stabilization of each step in the test regimes W1 to W4.

The transition period between one work rate and the next work rate shall be no more than one minute, which includes the stabilization, whilst the RPD remains in operational mode.

The work of breathing, breathing resistance and elastance shall be computed from the average pressure volume loop based on ten consecutive breaths and shall not exceed the limits given in Table 3.

Test regime to achieve W1:

a) 35 l/min for 5 min;

b) 10 l/min for 5 min;

c) 35 l/min for 5 min.

Test regime to achieve W2:

a) 35 l/min for 5 min;

b) 65 l/min for 5 min;

c) 10 l/min for 5 min;

d) 35 l/min for 5 min.

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Test regime to achieve W3:

a) 35 l/min for 4 min;

b) 65 l/min for 3 min;

c) 105 l/min for 3 min;

d) 10 l/min for 5 min;

e) 35 l/min for 5 min.

Test regime to achieve W4:

a) 35 l/min for 2 min;

b) 105 l/min for 3 min;

c) 65 l/min for 2 min;

d) 135 l/min for 3 min;

e) 10 l/min for 5 min;

f) 35 l/min for 5 min.

The test termination point shall be after one complete cycle of the applicable test regime. Each test regime shall be performed with the operation of the RPD adjusted to both the maximum and the minimum measured flow rates as determined by ISO 16900-8.

Table 3 — Limits of work of breathing, breathing resistance (peak pressure) and elastance for assisted and unassisted RPD

Flow rate (dynamic sinusoidal) l/min at BTPS	**Work of breathing limit measured as** WoB/V_T		**Breathing resistance limit** (peak pressures)		**Elastance limit measured as** $\Delta p/V_T$
	inhalation	**exhalation**	**inhalation**	**exhalation**	
	kPa		kPa		kPa/l
10 with a tolerance of ± 3 %[a]	0,9	0,9	-1,2	1,2	1,0
35 with a tolerance of ± 2%					
65 with a tolerance of ± 2%					
105 with a tolerance of ± 2%					
135 with a tolerance of ± 1%	1,6	1,6	-2,0	2,0	
Δp is the difference in pressure between the beginning of inhalation and beginning of exhalation.					
NOTE Flow rates and tidal volumes are expressed at BTPS (body temperature, ambient pressure, saturated gas).					

RPD work of breathing and breathing resistance (peak pressures) shall be measured in each step of the regime for the designated work rate class above. The measurements shall begin after the stabilization of each step.

The transition period between one work rate and the next work rate shall be no more than one minute, which includes the stabilization, whilst the RPD remains in operational mode.

During the transition between different flow rates, stopping of the breathing machine is allowable as long as the 1 min time period is not exceeded.

The settings for the breathing machine for each work rate are given in Table 2.

Testing shall be performed in accordance with ISO 17420-1 and ISO 16900-12.

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6.4 CO_2 concentration limits

6.4.1 CO_2 concentration limits for assisted RPD

One RPD in non pre-conditioned state, for each size RI shall be tested on the RPD headform based on the size as designated by the manufacturer.

RPD shall meet the requirements when tested at ambient temperature when adjusted to the measured minimum flow as tested in ISO 16900-8.

The carbon dioxide content of the inhalation air shall not exceed an average volume fraction as given in Table 4 tested at its work rate class and at resting to determine the average.

Table 4 — Maximum average volume fraction of CO_2 concentration in the inhalation air in relation to flow rate

Flow rate (dynamic sinusoidal) l/min at BTPS	**CO_2 concentration** %
10 with a tolerance of ±3%	2,50
35 with a tolerance of ±2%	2,00
65 with a tolerance of ±2%	
105 with a tolerance of ±2%	1,40
135 with a tolerance of ±1%	

After stabilization, the measurement of at least 10 cycles shall be taken to determine the average. Within at least 10 cycles the average value of CO_2 at the end of each exhalation cycle shall contain (5,3 ± 0,1) % CO_2.

The setting of the breathing machine is as given in Table 2.

Testing shall be performed in accordance with ISO 16900-9.

6.4.2 CO_2 concentration limits of unassisted RPD

One RPD in non pre-conditioned state, for each RI size shall be tested on the RPD headform based on the size as designated by the manufacturer.

The carbon dioxide content of the inhalation air shall not exceed an average volume fraction as given in Table 4 with the setting of the breathing machine as given in Table 2. After stabilization, the measurement of at least 10 cycles shall be taken to determine the average.

Within at least 10 cycles the average value of CO_2 at the end of each exhalation cycle shall contain (5,3 ± 0,1) % CO_2.

Testing shall be performed in accordance with ISO 16900-9.

6.4.3 CO_2 concentration limits for RI with standardized connector

One RI with standardized connector in non pre-conditioned state, for each size shall be tested on the RPD headform based on the size as designated by the manufacturer.

The carbon dioxide content of the inhalation air shall not exceed an average volume fraction as given in Table 4 for the flow rates of 10 l/min, 35 l/min and 65 l/min with the setting of the breathing machine as given in Table 2. After stabilization, the measurement of at least 10 cycles shall be taken to determine the average.

Within at least 10 cycles the average value of CO_2 at the end of each exhalation cycle shall contain (5,3 ± 0,1) % CO_2.

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Testing shall be performed in accordance with ISO 16900-9.

6.5 Noise limit for assisted RPD

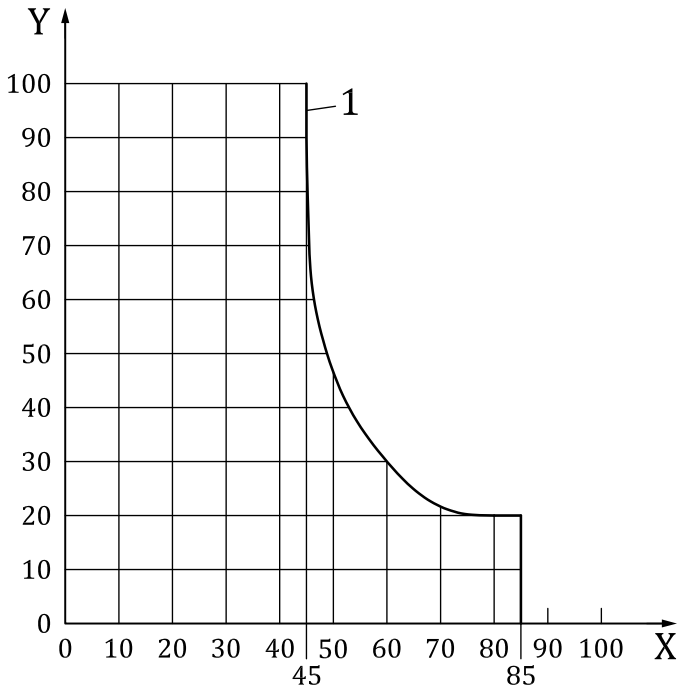
Only one RI size in non pre-conditioned state shall be tested.

RI Type d and e, when operated at the manufacturer's maximum flow conditions on a breathing machine set according to Table 2 for its work rate, and without activated warning device, the noise of the RPD shall be less than or equal to 80 dB(A) at both ears on the RPD headform. The measurement shall start 5 min after the activation of the RPD for a period of 5 min.

Testing shall be performed in accordance with ISO 16900-14:2020, method A.

6.6 Temperature and humidity of inhaled air for RPD which protect against CO

When tested in accordance with 6.10.1.3.2, Table 9, with the test gas concentration of 3 000 ml/m^3 CO, the temperature and relative humidity of the air supplied by the filtering RPD to the wearer shall not exceed the limits given in Figure 1, item 1, measured at the filter outlet. Preconditioning is required for filters only.



key

X temperature in °C

Y relative humidity in %

1 temperature limit for inhaled air

Figure 1 — Temperature and humidity curve for inhaled air

Testing shall be performed in accordance with ISO 16900-4.

6.7 Connections

6.7.1 General

If more than one connection is present on an RPD incorrect combinations shall be prevented by design. If for certain RPD systems such design solutions are not possible (for example for multiple-filter

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configuration), this shall be covered by information on the correct selection of combinations contained in the information supplied by the RPD manufacturer.

Check in accordance with 7.2.

6.7.2 Strength of connections – Connections to RI

RPD in non pre-conditioned state shall be tested.

Connections to a RI shall withstand the axial force perpendicular to the plane of affixation as defined in Table 5 and 6 and identified in Figure 2 and Figure 3. During the test it is acceptable that the direction of the force shift from the plane of affixation. The force shall be applied for $\left(10^{+2}_{0}\right)$ s when the RI is mounted on a headform, in accordance with the information supplied by the RPD manufacturer for proper donning by a wearer. The force shall be applied progressively avoiding an initial shock or jerking motion to the connection.

No further fixation means of the RI to the headform is allowed.

The RI is allowed to slip off the headform provided that the RI can be readily re-donned.

The F_{2a} and F_3 requirements apply to filters, exhalation valves and/or accessories attached to the RI only which have the potential of being snagged. These are identified by using the exposed surface identification probe defined in ISO 16900-5. The procedure for using the probe is given in ISO 16900-6.

As a result of the applied force, no connection or other component, including the components that attach the RI to the wearer, shall separate, break or permanently deform to such an extent that a further donning in accordance with the information supplied by the RPD manufacturer is no longer possible.

A separation or break of a component that does not affect the respiratory function of the RPD shall not be deemed a failure (e.g. heads-up display on the outside of the visor).

Testing shall be performed in accordance with ISO 16900-6 and checked in accordance with 7.2.

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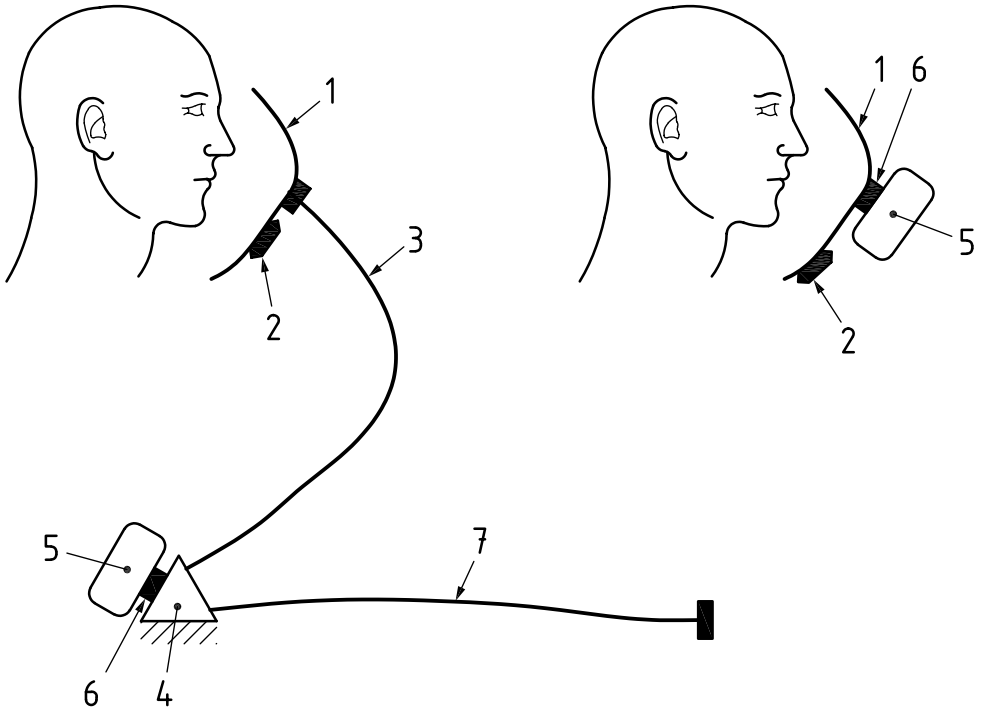

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1 RI
2 accessory/exhalation valve
3 breathing hose
4 fixation to wearer
5 filter
6 filter connection
7 low pressure hose

Figure 2 — Typical arrangements of RPD for pull force test

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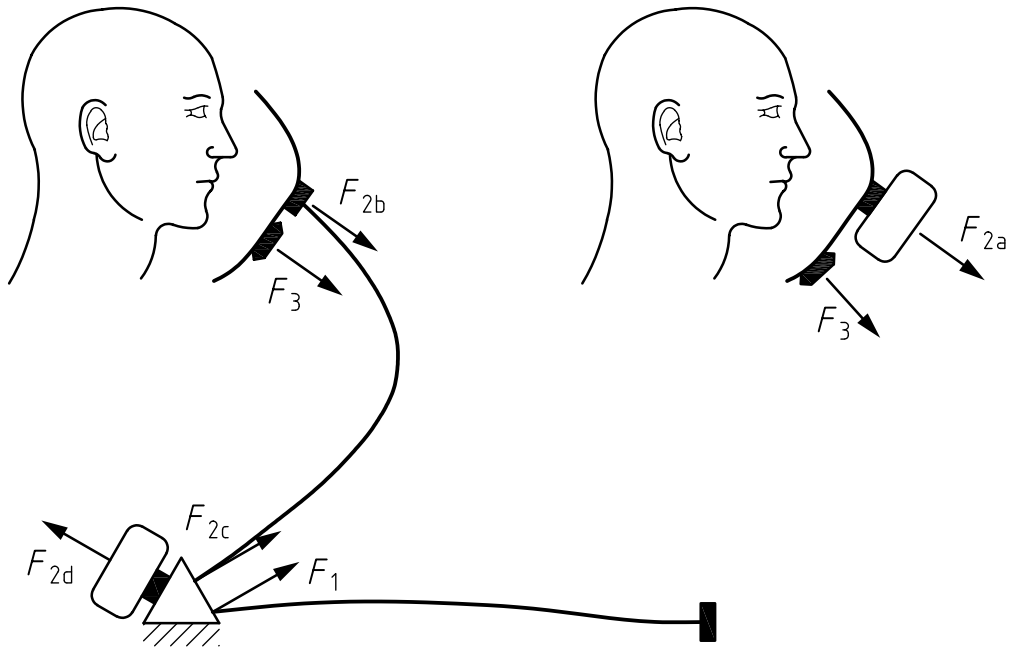

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F_1 pull force direction for connection between manifold and supply hose
F_{2a} pull force direction for connection between RI and filter
F_{2b} pull force direction for connection between RI and breathing hose
F_{2c} pull force direction for connection between manifold and breathing hose
F_{2d} pull force direction for connection between manifold and filter
F_3 pull force direction for connection between RI and accessories

Figure 3 — Pull force arrangement

Table 5 — Pull forces on RPD classes without standardized connector

Pull Force Area/Direction (Vectors)	F_1	F_{2a}	F_{2b}, F_{2c}, F_{2d}	F_3
	N			
PC 4 and greater	(1 000 ± 50)	(50 ± 2,5)	(250 ± 10)	(50 ± 2,5)
PC 3	(500 ± 25)	(25 ± 1)	(100 ± 5)	(10 ± 0,5)
PC 1 and PC 2	(500 ± 25)	(25 ± 1)	(50± 5)	(10 ± 0,5)

Table 6 — Pull forces on RPD class PC 2, PC 3 and PC 4 with standardized connector

Pull Force Area/Direction (Vectors)	F_1	F_{2a}	F_{2b}, F_{2c}, F_{2d}	F_3
	N			
PC 2, PC 3 and PC 4	NA	(100 ± 5)	(250 ± 10)	(50 ± 2,5)

6.7.3 Low pressure connections other than to the RI

RPD in non pre-conditioned state shall be tested.

Any low pressure connection of RPD other than those directly to the RI, such as filter(s) or hoses connected to a RPD, shall withstand a progressively applied axial force in accordance with Table 5 and 6 and identified in Figure 2 and Figure 4 for 10 s without separating, breaking or permanently deforming.

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to the extent a leak path is created. The force shall be applied progressively avoiding an initial shock or jerking motion to the connection.

After being exposed to the applied force, the hose connection shall be pressurized to (2 ± 0,2) kPa and submerged in water for 1 min unless separating, breaking or permanently deforming is observed on the hose connection. The connector shall not leak at a rate of more than one bubble per second.

For this test the components or sub-assemblies, such as filter housing or hose connector, may be used instead of a complete RPD.

One of each connection shall be tested.

Testing shall be performed in accordance with ISO 16900-6.

Check in accordance with 7.2, followed by testing in accordance with 7.3.

6.8 Assessment of reliability

Since many types of failure are possible, FMEA (failure mode and effects analysis) is a recommended way to examine failure situations and suggest safety design and procedures.

Manufacturers shall state, by providing a written declaration, that the reliability of the RPD or component was adequately considered in the design.

Special attention shall be given to the effects of

— temperature and humidity of inhaled air during use for filtering RPD which protects against contaminants other than CO,

— abrasion resistance,

— chemical resistance of materials,

— dusty environment,

— compatibility of materials with the wearer's body, and

— cleaning, disinfection and decontamination procedures and cycles on the function of the RPD.

In Annex A some aspects that should be considered by manufacturers to ensure reliability are indicated.

NOTE FMEA is a suitable tool to comply with this requirement.

6.9 Pre-conditioning (Sequential/Non-sequential)

6.9.1 General

The pre-conditioning shall follow the pre-conditioning test sequence as given Figure 4.

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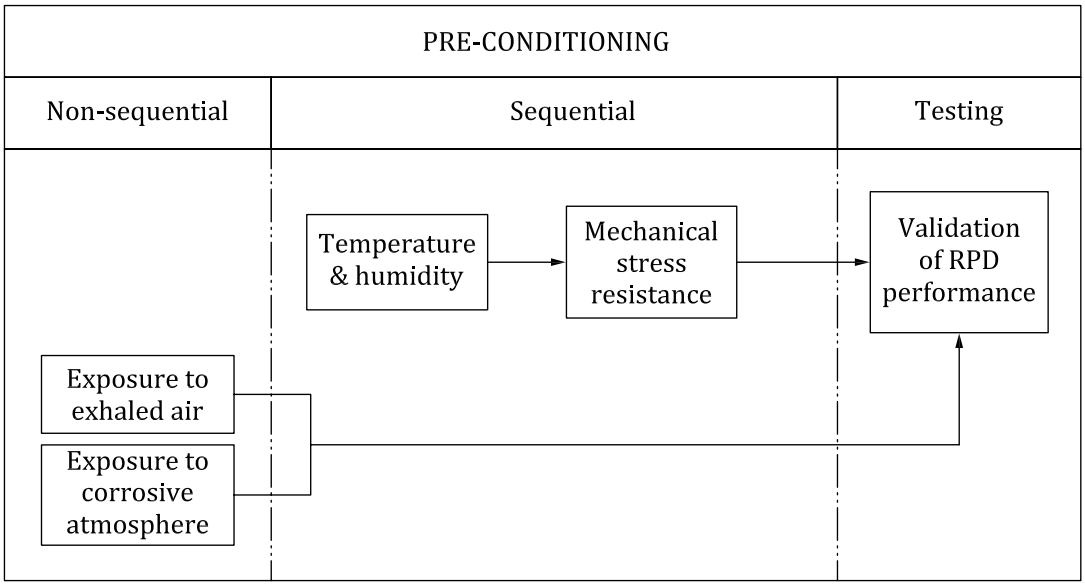

Figure 4 — Pre-conditioning test sequence

6.9.2 Sequential pre-conditioning

6.9.2.1 General

Integrated RPD and components shall be pre-conditioned in the following sequence:

— exposure to temperature and humidity conditioning, see 6.9.2.2;

— exposure to mechanical stress resistance, see 6.9.2.3.

6.9.2.2 Exposure to temperature and humidity

Integrated RPD and components shall be pre-conditioned in accordance with the following thermal cycle, without interruption:

— ambient temperature and humidity;

— (40 ± 3) °C and <20 % RH for (24 ± 1) h;

— (−10 ± 3) °C for (24 ± 1) h;

— (40 ± 3) °C and (90 ± 5) % RH for (24 ± 1) h; and

— ambient temperature between 16 °C and 32 °C and (50 ± 30) % RH until temperature is equilibrated.

In order to ensure that there is no temperature shock during the conditioning of the samples, the temperature gradient shall be less than 2 °C/min between phases at different temperatures, and between the beginning and the end of a thermal cycle.

The number of samples is given in the relevant requirement clauses.

6.9.2.3 Mechanical stress resistance

Integrated RPD, replaceable filter(s) and components containing electronics and/or electro-mechanics in their ready for assembly state shall be positioned in accordance with ISO 16900-6:—, 6.8, in the steel case in such a way that the samples do not touch each other during the test and allows horizontal movement and free vertical movement.

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