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Respiratory protective devices — Performance requirements —

Part 6: Special application escape - Filtering RPD and supplied breathable gas RPD

Appareils de protection respiratoire — Exigences de performances —

Partie 6: Application particulière d'évacuation - APR alimentés en gaz respirable et APR filtrants

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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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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.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document describes requirements for RPD including its elements and components used for special applications for escape devices.

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.

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.

Respiratory protective devices — Performance requirements —

Part 6:
Special application escape - Filtering RPD and supplied breathable gas RPD

1 Scope

This document specifies the requirements for supplied breathable gas RPD and for filtering RPD to be used for special application escape for use in the workplace to protect the wearer.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 8031, *Rubber and plastics hoses and hose assemblies — Determination of electrical resistance and conductivity*

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 16900-4, *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, *Respiratory protective devices — Methods of test and test equipment — Part 6: Mechanical resistance/strength of components and connections*

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 16900-10, *Respiratory protective devices — Methods of test and test equipment — Part 10: Resistance to ignition, flame, radiant heat and heat*

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*

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

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

ISO 17420-2:2021, *Respiratory protective devices — Performance requirements — Part 2: Requirements for filtering RPD*

ISO 17420-4:2021, *Respiratory protective devices — Performance requirements — Part 4: Requirements for supplied breathable gas RPD*

ISO 23269-2:2011, *Ships and marine technology — Breathing apparatus for ships — Part 2: Self-contained breathing apparatus for shipboard firefighters*

IEC 60068-2-27:2010, *Environmental testing — Part 2-27: Tests — Test Ea and guidance: Shock*

IEC 60068-2-64:2009, *Environmental testing — Part 2-64: Tests — Test Fh: Vibration, broadband random and guidance*

IEC 60079-0, *Explosive atmospheres — Part 0: Equipment — General requirements*

IEC 60079-11, *Explosive atmospheres — Part 11: Equipment protection by intrinsic safety "i"*

IEC 60079-32-1:2013, *Explosive atmospheres — Part 32-1: Electrostatics hazards — Guidance*

IEC 60079-32-2:2015, *Explosive atmospheres — Part 32-2: Electrostatics hazards — Tests*

IEC 60721-1:2003, *Classification of environmental conditions — Part 1: Environmental parameters and their severities*

IEC 60721-3-2:2018, *Classification of environmental conditions — Part 3-2: Classification of groups of environmental parameters and their severities — Transportation and Handling*

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

EN 50303, *Group 1, category M1 equipment intended to remain functional in atmospheres endangered by firedamp and/or coal dust*

3 Terms, definitions and abbreviations

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
RPD in as worn state
RPD where all components are connected and assembled in the way that it is intended to be used (e.g. worn by the wearer, adapted to an 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 RPD: blower unit, battery, 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
component in ready for assembly state
component with seals, plugs, packaging or other environmental protective means, still in place

3.1.4
RPD in ready for assembly state
RPD with seals, plug, or other environmental protective means, still in place

Note 1 to entry: In line with the information supplied by the manufacturer for donning the RPD, further actions can be necessary.

3.1.5
RPD in ready for use state
RPD ready to be donned as described by the manufacturer, but seals, plug, or other environmental protective means are already removed

Note 1 to entry: In line with the information supplied by the manufacturer for donning the RPD, further actions can be necessary.

Note 2 to entry: For escape devices this includes also the RPD in its container unopened.

3.2 Abbreviated terms

RI	Respiratory Interface
RPD	Respiratory Protective Devices
V_T	Tidal volume
WoB	Work of Breathing

4 Classification overview

ISO 17420-2:2021, Clause 4 or ISO 17420-4:2021, Clause 4 applies.

4.1 General

ISO 17420-1:2021, 4.1 applies.

The following subclause applies in addition to ISO 17420-2:2021, Clause 4:

4.2 Supplied breathable gas RPD for escape

In addition, supplied breathable gas RPD may be classified for one or more special applications, as given in Table 1.

Table 1 — Special application classification supplied breathable gas RPD

Special application	Classes
Escape	ES MN t^a (Underground mining escape) ES MA t^a (Marine escape) ES FF t^a (Escape from fire) ES t^a (Escape general supplied breathable gas)
[a] Nominal service life in *t* minutes, e.g. ES 15.	

Example for a special application escape with Protection class (PC4), RI class (dL) and special application class (ES 15).

EXAMPLE PC4 dL ES 15.

The following subclause applies in addition to ISO 17420-2:2021, Clause 4.

4.3 Filtering RPD for escape

In addition, filtering RPD may be classified for one or more special applications, as given in Table 2.

Table 2 — Special application classification of filtering RPD

Special application	Classes
Escape	ES MN t^a (Underground Mining Escape) ES FF t^a (Escape from fire) ES XX[b] t^a (Escape general filtering)
[a] Nominal service life in "t" minutes, e.g. ES 10. [b] Gas type.	

Example for a special application escape general with Protection class (PC3), RI class (bT) and special application escape (ES), particle filter performance class (F3) and gas filter class (AC) and class t (10).

EXAMPLE PC3 bT ES F3 AC10.

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

ISO 17420-1:2021, Clause 5 and ISO 17420-2:2021, Clause 5 or ISO 17420-4:2021, Clause 5 apply.

6 Basic requirements for supplied breathable gas RPD and filtering RPD

All requirements of ISO 17420-2:2021, Clause 6 or ISO 17420-4:2021, Clause 6 apply unless superseded by this document and indicated in the relevant clauses.

NOTE 1 Optional features are also given in ISO 17420-2 or ISO 17420-4.

NOTE 2 Where requirements are superseded by those in Clause 7 of this document test schedules given in ISO 17420-2:2021, Annex C or ISO 17420-4:2021, Annex C can be used as a guideline.

7 Special application for supplied breathable gas escape RPD and filtering escape RPD

7.1 Special application escape RPD - Requirement matrices

7.1.1 General

Supplied breathable gas escape RPD shall fulfil all requirements given in Table 3

Filtering escape RPD shall fulfil all requirements given in Table 4.

7.1.2 Supplied breathable gas RPD — Escape

Table 3 gives an overview about requirements and preconditioning of special application supplied breathable gas RPD — Escape.

For each line in the table, at least one RPD shall be tested after the required preconditioning or set of pre-conditionings where combined by “&”. Combined preconditioning shall be completed in the order specified.

Table 3 shall be read as follows:

In the first column the clause numbers of the requirements are given. In the third to sixth column the required pre-conditioning for different escape classes are given.

In the second column the requirement is titled.

For each pre-conditioning within one line of the cell different sample(s) shall be used.

For the requirement 7.2.10.1 and class marine escape the following applies:

At least one sample shall be pre-conditioned TH&VSS&IE (Exposure to temperature and humidity, exposure to vibration and shock – marine and intermittend exposure).

At least one further sample shall be pre-conditioned DR (Exposure to impact from drop).

For the total number of samples see ISO 17420-1:2021, 5.1.

Table 3 — Special application requirement overview — Supplied breathable gas RPD — Escape

Requirement	Title	Supplied breathable gas escape general ES t[a]	Escape from fire ES FF t[a]	Marine escape ES MA t[a]	Underground mining escape ES MN t[a]
		Protection class ≥PC3	Protection class ≥PC3	Protection class ≥PC3	Protection class ≥PC3
		Pre-conditioning			
7.2.1	Exposure to dust	X[b]	X[b]	X[b]	X[b]
7.2.2.1[c]	Contact with hot and cold surfaces – Supplied breathable gas escape RPD	TH&VS&IE	TH&VSF&IE	TH&VSS&IE	TH&VSM&PR&IE
7.2.3	Avoidance of frictional sparks	AR/NP	AR/NP	AR/NP	AR/NP
7.2.4.1	Six burner dynamic	—[d]	AR	AR	AR
7.2.6.2	Intrinsic Safety – Firefighting	—[d]	AR/NP	—[d]	—[d]
7.2.6.3	Intrinsic Safety – Mining	—[d]	—[d]	—[d]	AR/NP
7.2.6.4	Intrinsic Safety – Marine	—[d]	—[d]	AR/NP	—
7.2.7.1	Antistatic properties - General	—[d]	AR/NP	AR/NP	AR/NP

[a] Nominal service life in "t" min, see also 7.2.9.1.

[b] X means exposure to dust has to be addressed by the FMEA (see 7.2.1).

[c] Will be determined during the validation of escape RPD performance regime specified in 7.2.10.

[d] — means that a test is not required for this combination of requirement and special application class.

AR as received.

AR/NP as received or in non pre-conditioned state.

TH&VS&IE Exposure to temperature and humidity (ISO 17420-4:2021, 6.11.1.1.2), exposure to vibration and shock (ISO 17420-4:2021, 6.11.1.1.3) and intermittent exposure to salt spray (7.3.3).

TH&VSF&IE Exposure to temperature and humidity (ISO 17420-4:2021, 6.11.1.1.2), exposure to vibration and shock-fire fighting (ISO 17420-5:—, 7.3.2) and intermittent exposure to salt spray (7.3.3).

TH&VSS&IE Exposure to temperature and humidity (ISO 17420-4:2021, 6.11.1.1.2), exposure to vibration and shock marine (7.3.5) and intermittent exposure to salt spray (7.3.3).

TH&VSM&PR&IE Exposure to temperature and humidity (ISO 17420-4:2021, 6.11.1.1.2), exposure to vibration and shock mining (7.3.6), resistance to changes in atmospheric pressure (7.3.2) and intermittent exposure to salt spray (7.3.3).

DR Exposure to impact from drop (7.3.1).

Table 3 *(continued)*

7.2.7.2	Antistatic properties – Fire-fighting	—[d]	AR/NP	—[d]	—[d]
7.2.7.3	Antistatic properties - Mining	—[d]	—[d]	—[d]	AR/NP
7.2.7.4	Antistatic properties - Exposed RPD hoses	—[d]	AR/NP	AR/NP	AR/NP
7.2.8	Eye irritation (external)	AR/NP	AR/NP	AR/NP	AR/NP
7.2.9.2	Determination of duration (t) of Escape RPD	TH&VS&IE	TH&VSF&IE	TH&VSS&IE	TH&VSM&PR&IE
		DR	DR	DR	DR
7.2.10.1	Validation of escape RPD performance requirements	TH&VS&IE	TH&VSF&IE	TH&VSS&IE	TH&VSM&PR&IE
		DR	DR	DR	DR
7.2.10.4	Donning and doffing	AR/NP	AR/NP	AR/NP	AR/NP

[a] Nominal service life in "t" min, see also 7.2.9.1.

[b] X means exposure to dust has to be addressed by the FMEA (see 7.2.1).

[c] Will be determined during the validation of escape RPD performance regime specified in 7.2.10.

[d] — means that a test is not required for this combination of requirement and special application class.

AR as received.

AR/NP as received or in non pre-conditioned state.

TH&VS&IE Exposure to temperature and humidity (ISO 17420-4:2021, 6.11.1.1.2), exposure to vibration and shock (ISO 17420-4:2021, 6.11.1.1.3) and intermittent exposure to salt spray (7.3.3).

TH&VSF&IE Exposure to temperature and humidity (ISO 17420-4:2021, 6.11.1.1.2), exposure to vibration and shock-fire fighting (ISO 17420-5:—, 7.3.2) and intermittent exposure to salt spray (7.3.3).

TH&VSS&IE Exposure to temperature and humidity (ISO 17420-4:2021, 6.11.1.1.2), exposure to vibration and shock marine (7.3.5) and intermittent exposure to salt spray (7.3.3).

TH&VSM&PR&IE Exposure to temperature and humidity (ISO 17420-4:2021, 6.11.1.1.2), exposure to vibration and shock mining (7.3.6), resistance to changes in atmospheric pressure (7.3.2) and intermittent exposure to salt spray (7.3.3).

DR Exposure to impact from drop (7.3.1).

7.1.3 Filtering escape RPD

Table 4 gives an overview about requirements and preconditioning of filtering RPD.

At least one RPD shall be tested after each required preconditioning. Pre-conditionings shall not be combined.

Table 4 shall be read as follows:

In the first column the requirements are given. In the third to fifth column the required pre-conditioning for different escape classes are given.

In the second column the requirement is titled.

For each pre-conditioning within one line of the cell different sample(s) shall be used.

For the requirement 7.2.10.2.2 and class mining escape the following applies:

At least one sample shall be pre-conditioned TH&VSM&PR&IE (Exposure to temperature and humidity, exposure to vibration and shock – mining, exposure to positive pressure and intermittent exposure).

At least one further sample shall be pre-conditioned DR (Exposure to impact from drop).

For the total number of samples see ISO 17420-1:2021, 5.1.

Table 4 — Special application requirement overview — Filtering RPD — Escape

Requirement	Title	Filtering escape general	Escape from fire	Underground mining escape
		ES XX[a] *t*[b]	**ES FF *t*[b]**	**ES MN *t*[b]**
		Protection class ≥PC3	Protection class ≥PC3	Protection class ≥PC3
		Pre-conditioning		
7.2.1	Exposure to dust	X[c]	X[c]	X[c]
7.2.2.2[d]	Contact with hot surfaces - Filtering escape RPD	TH&MR	TH&VSF	TH&VSM&PR&IE
		DR		
7.2.3	Avoidance of frictional sparks	—[e]	AR	AR
7.2.4.1	Six burner dynamic	—[e]	AR	AR
7.2.6.2	Intrinsic Safety – Firefighting	—[e]	AR	—[e]
7.2.6.3	Intrinsic Safety – Mining	—[e]	—[e]	AR
7.2.7.1	Antistatic properties - General	AR	AR	AR
7.2.7.2	Antistatic properties Firefighting	—[e]	AR	—[e]
7.2.7.3	Antistatic properties - Mining	—[e]	—[e]	AR
7.2.7.4	Antistatic properties - Exposed RPD hoses	—[e]	AR	AR
7.2.8	Eye irritation (external)	AR	AR	AR
7.2.9.3	Determination of duration (*t*) of filtering escape RPD	TH&MR	TH&VSF	TH&VSM&PR
		DR	DR	DR
7.2.10.2.1	Performance of work of breathing / breathing resistance/ elastance for un-	TH&MR&IE	TH&VSF&IE	TH&VSM&PR&IE
		DR	DR	DR
7.2.10.2.2	Performance of work of breathing/breathing resistance/elastance for assisted	TH&MR&IE	TH&VSF&IE	TH&VSM&PR&IE
		DR	DR	DR
7.2.10.3	CO_2 concentration limits	AR	AR	AR
7.2.10.4	Donning and doffing	AR/NP	AR/NP	AR/NP

[a] Gas type.

[b] nominal service life in "t" min, see also 7.2.9.1.

[c] X means exposure to dust has to be addressed by the FMEA (7.2.1).

[d] Will be determined during the performance of work of breathing/breathing resistance/elastance for unassisted (7.2.10.2.1) or assisted escape RPD (7.2.10.2.2).

[e] — means that a test is not required for this combination of requirement and special application class.

AR as received (or in non pre-conditioned state).

DR Exposure to impact from drop (7.3.1).

TH&MR Exposure to temperature and humidity (ISO 17420-2:2021, 6.9.2.2), Mechanical resistance test (ISO 17420-2:2021, 6.9.2.3).

TH&MR&IE Exposure to temperature and humidity (ISO 17420-2:2021, 6.9.2.2), Mechanical resistance test (ISO 17420-2:2021, 6.9.2.3) and intermittent exposure (7.3.3).

TH&VSF Exposure to temperature and humidity (ISO 17420-2:2021, 6.9.2.2), Vibration and shock–fire-fighting (ISO 17420-5:—, 7.3.2).

TH&VSF&IE Exposure to temperature and humidity (ISO 17420-2:2021, 6.9.2.2), Vibration and shock–fire-fighting (ISO 17420-5:—, 7.3.2) and intermittent exposure (7.3.3).

TH&VSM&PR Exposure to temperature and humidity (ISO 17420-2:2021, 6.9.2.2), Vibration and shock–mining (7.3.6), resistance to changes in atmospheric pressure (7.3.2).

TH&VSM&PR&IE Exposure to temperature and humidity (ISO 17420-2:2021, 6.9.2.2), Vibration and shock–mining (7.3.6), resistance to changes in atmospheric pressure (7.3.2) and intermittent exposure (7.3.3).

Table 4 *(continued)*

7.2.10.6	Class Escape filtering RPD	TH&MR DR	—[e]	—[e]
7.2.10.6.1	General filtering RPD	TH&MR DR	—[e]	—[e]
7.2.10.6.2	Escape from fire	—[e]	TH&VSF DR	—[e]
7.2.10.6.3	Escape Mining	—[e]	—[e]	TH&VSM&PR DR
7.2.10.7	Short time breakthrough test for gas filter(s) other than type CO	TH&MR DR	TH&VSF DR	TH&VSM&PR DR
7.2.10.8	Short time breakthrough test for gas filter(s) type CO	TH&MR DR	TH&VSF DR	TH&VSM&PR DR

[a] Gas type.

[b] nominal service life in "t" min, see also 7.2.9.1.

[c] X means exposure to dust has to be addressed by the FMEA (7.2.1).

[d] Will be determined during the performance of work of breathing/breathing resistance/elastance for unassisted (7.2.10.2.1) or assisted escape RPD (7.2.10.2.2).

[e] — means that a test is not required for this combination of requirement and special application class.

AR as received (or in non pre-conditioned state).

DR Exposure to impact from drop (7.3.1).

TH&MR Exposure to temperature and humidity (ISO 17420-2:2021, 6.9.2.2), Mechanical resistance test (ISO 17420-2:2021, 6.9.2.3).

TH&MR&IE Exposure to temperature and humidity (ISO 17420-2:2021, 6.9.2.2), Mechanical resistance test (ISO 17420-2:2021, 6.9.2.3) and intermittent exposure (7.3.3).

TH&VSF Exposure to temperature and humidity (ISO 17420-2:2021, 6.11.1.1.2), Vibration and shock –fire-fighting (ISO 17420-5:—, 7.3.2).

TH&VSF&IE Exposure to temperature and humidity (ISO 17420-2:2021, 6.9.2.2), Vibration and shock –fire-fighting (ISO 17420-5:—, 7.3.2) and intermittent exposure (7.3.3).

TH&VSM&PR Exposure to temperature and humidity (ISO 17420-2:2021, 6.9.2.2), Vibration and shock –mining (7.3.6), resistance to changes in atmospheric pressure (7.3.2).

TH&VSM&PR&IE Exposure to temperature and humidity (ISO 17420-2:2021, 6.9.2.2), Vibration and shock –mining (7.3.6), resistance to changes in atmospheric pressure (7.3.2) and intermittent exposure (7.3.3).

7.2 Requirements for special application escape RPD

7.2.1 Exposure to dust

RPD in ready for use state and component in ready for assembly state shall withstand the effects of dusty environment. This has to be addressed by the FMEA. See ISO 17420-2:2021, 6.8, or ISO 17420-4:2021, 6.10.

7.2.2 Contact with hot or cold surfaces generated by the RPD

7.2.2.1 Contact with hot and cold surfaces – Supplied breathable gas escape RPD

This subclause supersedes ISO 17420-4:2021, 6.7.

Uncoated metal surface of the RPD that may come in contact with the dressed wearer's body during normal use shall not exceed 65° C or be less than -10° C. Other material surfaces of the RPD that may come in contact with the dressed wearer's body during normal use shall not exceed 70° C.

Surfaces that may come in contact with the wearer's hands for the purpose of adjustment of the RPD shall not exceed 60 °C.

The RPD surface temperatures shall be measured when tested for escape RPD in accordance with 7.2.10 and the temperatures shall be recorded in order to determine presence of hot or cold surfaces.

A warning concerning the potential for hot and/or cold surface temperatures shall be given in information supplied by the manufacturer.

7.2.2.2 Contact with hot surfaces - Filtering escape RPD

There shall be no contact of hot surfaces exceeding 65 °C for uncoated metal surfaces and 70 °C for other surface material, of RPD with the skin of the wearer during normal use, with the exception of the wearer's hands if adjustment can be necessary.

A warning concerning the potential danger for hot surface temperatures shall be given in information supplied by the RPD manufacturer.

Check in accordance with 8.2.

7.2.3 Avoidance of frictional sparks - Filtering escape RPD and supplied breathable gas escape RPD

RPD shall not have exposed unprotected metal components manufactured from Magnesium, Titanium, Aluminium, or of their alloys, containing these metals which, on impact with rusted iron or steel, are likely to produce sparks capable of igniting flammable gas/air mixtures. Protective surface finishes include, but are not limited to, thermal spray, anodizing, powder coating, hard coating, and liquid paint. Exposed components are those that can be touched, during use, by the exposed surface identification probe as specified in ISO 16900-5.

Check in accordance with 8.2.

7.2.4 Resistance to flame

7.2.4.1 Six burner dynamic - Filtering escape RPD and supplied breathable gas escape RPD

This subclause supersedes ISO 17420-1:2021, 5.3 for the RI only.

One RI as received shall be tested for flame and heat resistance as specified in ISO 16900-10. Prior to testing, all components and accessories, which are claimed by the manufacturer as part of the RPD, shall be assembled with the RI. The components and accessories shall be in as received state. There shall be no dripping at all, and the assembly under test shall not continue to burn for more than 5 s.

Deformation/decomposition is allowed, as long as it does not drip or burn through or present any other hazard to the wearer.

The tip of each burner shall be set at 250 mm from the closest point upon which that flame will impinge, following the contour of the RI and component contour.

The RPD or the RI does not need to fulfil any other requirement of this standard after this test.

Check in accordance with 8.2.

7.2.5 Mechanical Requirement

7.2.5.1 Connections

7.2.5.1.1 Connections to RI

ISO 17420-4:2021, 6.14.3.1 applies.

Table 5 supersedes ISO 17420-4:2021, 6.14.3.1, Table 9 and 10.

Table 5 — Pull forces — Special application

Pull Force Area/Direction	*F*1	*F*2a	*F*2b	*F*3
Vectors	N			
Special application	(1 000 ± 50)	(500 ± 25)	(500 ± 25)	(50 ± 2,5)

7.2.5.1.2 Connections other than to the RI

ISO 17420-4:2021, 6.14.3.2 applies.

Two samples shall be tested.

Table 5 in 7.2.5.1.1 supersedes ISO 17420-4:2021, 6.14.3.1, Table 9 and 10.

7.2.6 Requirements for escape RPD used in explosive atmospheres and electromagnetic compatibility

7.2.6.1 General - Filtering escape RPD and supplied breathable gas escape RPD

If the RPD or components are equipped with an electric energy source or have electrically operating parts these components shall comply with IEC 60079-0 at the temperature of operation specified within the IEC standards or equivalent national standards.

If the information supplied by the manufacturer states that the RPD is electromagnetically compatible (EMC), the RPD shall comply with the IEC 61000 EMC Publications or other equivalent national programs.

7.2.6.2 Escape from fire - Filtering escape RPD and supplied breathable gas escape RPD

If the RPD or components are equipped with an electric energy source, exothermic source or has electrically operating parts these components shall comply with the class 2G EEx ib IIB T4 in accordance with IEC 60079-0.

7.2.6.3 Mining - Filtering escape RPD and supplied breathable gas escape RPD

If the RPD or components are equipped with an electric energy source, exothermic source or has electrically operating parts these components shall comply with M1 EEx ia I, in accordance with IEC 60079-0 in combination with the EN 50303 respectively.

NOTE EN 50303 specifically addresses mining conditions such as gas and dust threats.

7.2.6.4 Marine - Supplied breathable gas escape RPD

If the RPD or components are equipped with an electric energy source, exothermic source or has electrically operating parts these components shall comply with the class 2G EEx ib IIB T4 in accordance with IEC 60079-0.

7.2.7 Antistatic properties - Filtering escape RPD and supplied breathable gas escape RPD

7.2.7.1 General - Filtering escape RPD and supplied breathable gas escape RPD

Exposed parts, except RPD hoses, shall be tested according to the class as given in 7.2.6.2, 7.2.6.3 or 7.2.6.4, respectively. Testing shall be in accordance with ISO 80079-36: 2016. Testing by charging with a DC high voltage power supply (ISO 80079-36:2016, D.4.2.3) can be excluded, as long as highly efficient charge generating mechanisms (fast separation processes, e.g. films moving over rollers, drive belts, loading arm operation and bulk hydrocarbon transfer) are unlikely to be present.

A warning shall be given in the information supplied by the manufacturer.

Exposed parts are those that can be touched, during use, by the exposed surface identification probe as specified in ISO 16900-5.

Exposed RPD hoses shall meet the requirement in 7.2.7.5.

7.2.7.2 Escape from fire - Filtering escape RPD and supplied breathable gas escape RPD

Testing in accordance with 7.2.7.1 shall be conducted for class 2G, Group IIB requirements.

7.2.7.3 Mining - Filtering escape RPD and supplied breathable gas escape RPD

Testing in accordance with 7.2.7.1 shall be conducted for class M1, Group I requirements.

7.2.7.4 Marine - Supplied breathable gas escape RPD

Testing in accordance with 7.2.7.1 shall be conducted for class 2G, Group IIB requirements.

7.2.7.5 Exposed RPD hoses - Filtering escape RPD and supplied breathable gas escape RPD

Exposed RPD hoses shall have an insulation resistance that is greater than 10^3 Ω and less than 10^8 Ω.

Exposed RPD hoses are those that can be touched, during use, by the exposed surface identification probe as specified in ISO 16900-5.

Testing shall be performed in accordance with ISO 8031.

7.2.8 Eye irritation (external) - Filtering escape RPD and supplied breathable gas escape RPD

RPD with RI covering the wearers' eyes but with ocular zone not being purged by inhalation air shall provide eye protection against eye-irritating substances.

This shall be demonstrated by a maximum TIL of 20 % when sampling from the ocular area.

Exercises given in Table 6 shall be performed with crosswinds.

Table 6 — Crosswind testing — Exercises of ISO 16900-1:2019, Table B.1

Air flow direction	Exercises	Test subject		
		1	2	3
Front	6)	x		
	7)	x		
	8)	x		
Side	6)		x	
	7)		x	
	8)		x	

Table 6 *(continued)*

Air flow direction	Exercises	Test subject		
		1	2	3
Rear	6)			x
	7)			x
	8)			x

Testing shall be performed with three test subjects.

Testing shall be performed in accordance with ISO 16900-1:2019, 11.3.

7.2.9 Determination of duration

7.2.9.1 General

All escape RPD in ready for use state shall be capable of being donned and doffed in the dark without assistance.

Escape RPD are designated by the duration "*t*" in min, following the increments of:

— 5 min between 5 min and 30 min (5, 10, 15, 20, 25, 30);

— 10 min above 30 min to 60 min (40, 50, 60);

— 30 min above 60 min to 120 min (90, 120) and

— 60 min above 120 min (180, 240.....)

7.2.9.2 Determination of duration, *t*, of supplied breathable gas escape RPD

7.2.9.2.1 Class T (tight fitting) RIs using compressed breathable gas

This subclause supersedes ISO 17420-4:2021, 6.4.2.

The duration of the Escape RPD shall be calculated as the capacity divided by the ventilation rate of 35 l/min. Where the capacity, V_c, shall be calculated as the water capacity (volume) of the cylinder multiplied by the working pressure, it shall be corrected to BTPS values and divided by the compressibility factor for the breathable air or gas mixtures down to 1,0 MPa [see Formula (1)].

$$V_c = \frac{(p-1{,}0)\times V_w}{Z\times p_{atm}} \times f_{BTPS} \quad (1)$$

where

p is the working pressure, in MPa;

p_{atm} is the atmospheric pressure in MPa = 0,1013 MPa;

V_w is the water capacity of the cylinder in litres;

f_{BTPS} is the constant correction factor to convert the capacity at 15 °C to the capacity at BTPS = 37 °C, which is 1,076;

Z is the compressibility factor at 15 °C or the air or gas mixtures at working pressur, p.

Compressibility factor for air is given in Table 7 and the compressibility factor for gas mixtures shall be determined and rounded to two decimals.

Table 7 — Compressibility factor for air at 15 °C

Working pressure p MPa	Compressibility Factor Z
10	0,98
15	1,00
20	1,02
25	1,05
30	1,10
40	1,20

EXAMPLE Cylinder with working pressure 300 bar and a water capacity of 2,0 l.

$$V_c = \frac{(p-1{,}0)\times V}{Z \times p_{atm}} \times f_{BTPS}$$

where

p = 300 bar = 30 MPa

V_w = 2,0 l

Z = 1,10

P_{atm} = 0,1 MPa

V_c = $(p\text{-}1{,}0) \times V_w \times f_{BTPS}/(Z \times p_{atm})$

= (30 MPa − 1,0 MPa) × 2,0 l × 1,076/(1,1 × 0,1013 MPa) = 560 l

Calculation of duration

$$\frac{560\,\text{l}}{35\,\text{l/min}} = 16{,}0 \text{ min rounded to } 15 \text{ min.}$$

7.2.9.2.2 Class L (loose fitting) RIs using compressed breathable gas

This subclause supersedes ISO 17420-4:2021, 6.4.3.

One Escape supplied breathable gas RPD shall be tested at ambient temperature at a flow rate of 35 l/min with a tolerance of ±3 % (dynamic) and a breathing machine setting of tidal volume of 1,5 l at BTPS and a frequency of 23,3 cycles per minute. The duration test terminates when the performance requirements specified in 7.2.10.1.2 and 7.2.10.1.3 are no longer met.

Results need to be corrected in relation to the ambient pressure conditions in accordance with Formula (2).

$$t_{BTPS} = t_{meas} \times \frac{p_{amb}}{p_{BTPS}} \quad (2)$$

where

t_{meas} is the measured duration time;

p_{amb} is the ambient atmospheric pressure during the test in hPa;

p_{BTPS} is the atmospheric pressure at BTPS conditions in hPa = 1 013 hPa.

EXAMPLE Measured duration, t_{BTPS}, is 14,5 min ambient pressure is 1 005 hPa.

t_{BTPS} = 14,5 min × (1 005 hPa/1 013 hPa) = 14, 4 min

t_{BTPS} rounded to duration class 10 min

7.2.9.2.3 Supplied breathable gas escape RPD not using compressed breathable gas

This subclause supersedes ISO 17420-4:2021, 6.4.4.

One RPD, in non pre-conditioned state, shall be tested at (22 ± 3) °C and (50 ± 25) % relative humidity at a flow rate of 35 l/min with a tolerance of ±3 % (dynamic sinusoidal), a breathing simulator setting of tidal volume of 1,5 l at BTPS, a frequency of 23,3 cycles per minute and a CO_2 dosage of a volume fraction of 2,6 %.

The duration test terminates when the performance requirements specified in 7.2.10.1.2, 7.2.10.1.3, 7.2.10.1.4 and 7.2.10.1.5, if applicable or 7.2.10.1.6 if applicable, are no longer met.

7.2.9.3 Determination of duration (*t*) of filtering escape RPD

7.2.9.3.1 Capacity of gas filters for unassisted and assisted escape RPD of class escape general

The filter capacity shall meet or exceed the designated duration (*t*) when tested with the parameters given in Table 11.

7.2.9.3.2 Designated duration (*t*) of assisted Escape filtering RPD of class escape general

The assisted escape RPD shall be tested at 35 l/min sinusoidal until the time which is given by the designated duration, *t*. During this test the performance requirements for work of breathing/ breathing resistance and CO_2 shall be within the limits given in Table 10 and 7.2.10.3.1

7.2.10 Validation of escape RPD performance requirements

7.2.10.1 Supplied breathable gas escape RPD

7.2.10.1.1 General

Two Escape RPD of each RI size shall be pre-conditioned in accordance with the sequential pre-conditioning in accordance with

— ISO 17420-4:2021, 6.11.1.1.2 followed by ISO 17420-4:2021, 6.11.1.1.3 for ES(*t*), or

— ISO 17420-4:2021, 6.11.1.1.2 followed by 7.3.5 for ES MA(*t*) respectively, or

— ISO 17420-4:2021, 6.11.1.1.2 followed by 7.3.6 for ES MN(*t*) respectively.

One additional Escape RPD shall be pre-conditioned in accordance with 7.3.3, if metal parts are included.

One additional Escape RPD shall be pre-conditioned in accordance with 7.3.1.

RPD shall meet the requirements specified in 7.2.10.1.2 to 7.2.10.1.6 when tested according to the steps within the performance regime escape equilibrated at $\begin{pmatrix} 0 \\ 35 \\ -2 \end{pmatrix}$ °C and $\begin{pmatrix} +2 \\ -5 \\ 0 \end{pmatrix}$ °C.

Two RPD of each RI size shall be equilibrated and tested at each specified test temperature.

The RPD shall be tested in accordance with the performance regime escape and meet the requirements specified in 7.2.10.1.2 to 7.2.10.1.6 for each flow rate step at dynamic testing.

The test termination point for class RPD for escape shall be when any one of the above criteria for the RPD's class is no longer met.

Performance regime escape designated flow rates with the setting of the metabolic simulator in accordance with ISO 17420-4:2021, Table 2:

a) 35 l/min for 2 min;

b) 65 l/min for 3 min;

c) 35 l/min for 7 min;

d) 10 l/min for 3 min;

e) repeat steps a) to d) above until the test termination point.

If the termination point does not allow to complete step c) and d), at least once, the test shall be terminated and a separate 10 l/min test shall be performed for the duration as indicated by the termination point.

If the termination point has been reached after step b) (5 min) the separate 10 l/min-test shall be performed for 5 min.

The transition period between one flow rate and the next flow rate shall be no more than 30 s whilst the RPD is still functioning.

During the transition between the settings of the different flow rates, stopping of the breathing machine for more than 5 s is not allowable for those types of RPD using enriched or generated oxygen.

One RPD, as received, for each size and for each temperature: 35 °C and -5 °C (or if outside these temperatures as specified by manufacturer) shall be tested on the RPD headform based on the size as designated by the manufacturer. If the RPD is designated for all sizes, all the headforms or mouthpiece fixation, whatever is applicable, shall be used.

Test in accordance with ISO 16900-5 and ISO 16900-12.

7.2.10.1.2 Work of breathing and breathing resistance

This subclause supersedes ISO 17420-4:2021, 6.3.

RPD work of breathing and breathing resistance (peak pressures) shall be measured in each step of the performance regime escape, given in 7.2.10. The measurements shall begin after the stabilization of each step but no later than 1 min after change to new flow rate setting.

The average measurements of any ten consecutive breaths shall not exceed the following limits given in Table 8.

Table 8 — Limits for average measurements

Designated flow rate escape (dynamic sinusoidal)	**Work of Breathing Limit** (WoB/V_T)		**Breathing Resistance** (Peak Pressures)		**Elastance**
	Inhalation	Exhalation	Inhalation	Exhalation	
l/min	kPa		kPa		kPa/l
65 (with a tolerance of ±2 %)	0,9	0,9	–1,2	1,2	1,0
35 (with a tolerance of ±2 %)	0,9	0,9	–1,2	1,2	1,0
10 (with a tolerance of ±3 %)	0,9	0,9	–1,2	1,2	1,0

Test in accordance with 7.2.10.1 and ISO 16900-12.

7.2.10.1.3 CO_2 concentration limits

This subclause supersedes ISO 17420-4:2021, 6.5.

When tested at the performance regime escape as specified in 7.2.10.1.1, for the first step of the performance regime for 2 min the CO_2 concentration of the inhaled air shall not exceed 3 %.

For the second step of the performance regime for 3 min the CO_2 concentration of the inhaled air shall not exceed an average of 2 % over the 3 min and shall not exceed 3 % at any time.

For the third step of the performance regime for 7 min the CO_2 concentration of the inhaled air shall not exceed an average of 2 % over the 7 min and shall not exceed 3 % at any time.

For the fourth step of the performance regime for 3 min the CO_2 concentration of the inhaled air shall not exceed an average of 2,5 % over the 3 min and shall not exceed 3 % at any time.

In case that the regime has to be repeated according to the duration of the RPD, the limits for the first step for 2 min the CO_2 concentration of the inhaled air shall not exceed an average of 2 % over the 2 min and shall not exceed 3 % at any time.

The CO_2 concentration of the inhalation air shall not exceed the limits given above after correction by subtraction of the ambient CO_2-level in the laboratory.

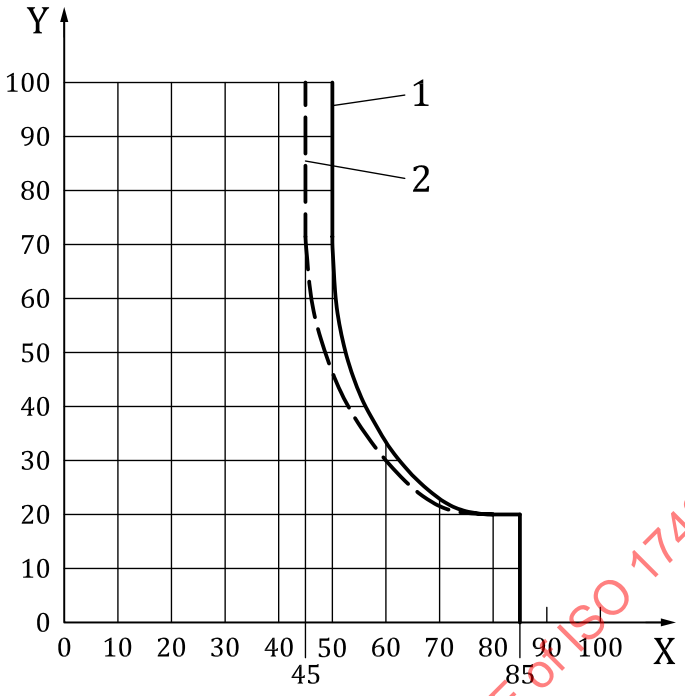
A peak of CO_2 concentration resulting from the switch of the testing equipment from one work rate level to the next shall not be considered as a failure and shall not be assessed during the CO_2 measurement.

Testing shall be performed in accordance with ISO 16900-9 using the performance regimes escape specified in 7.2.10.1.1.

7.2.10.1.4 Temperature and humidity of inhaled gas for regenerated breathable gas RPD escape and oxygen enriched breathable gas RPD escape

This subclause supersedes ISO 17420-4:2021, 6.6.

The temperature and relative humidity of the gas mixture supplied by the RPD to the wearer shall not exceed the temperature and humidity limits as given in Figure 1.



key

X temperature in °C

Y relative humidity in %

1 temperature limit for inhaled air for special application ES

2 temperature limit for inhaled air for RPD other than special application ES, for information only

Figure 1 — Temperature and humidity curve for inhaled air

Inhalation temperature limits for flow rates of 10 l/min, 35 l/min and 65 l/min shall be ≥−30°C.

7.2.10.1.5 Oxygen content of RPD using regenerated breathable gas

This subclause supersedes ISO 17420-4:2021, 6.8.1.

The oxygen concentration shall be no less than 20,9 % when tested in accordance with ISO 16900-13 and ISO 16900-5 using the performance regime escape specified in 7.2.10. The oxygen concentration at start up may be lower than 20,9 % but shall be greater than 17 % for the initial 3 min. After an additional 30 s the concentration shall be at least 20,9 %.

Number of samples, pre-conditioning and prerequisites are specified in 7.2.10.

7.2.10.1.6 Oxygen content of RPD using oxygen enriched breathable gas

This subclause supersedes ISO 17420-4:2021, 6.8.2.

The oxygen concentration shall be no less than 20,9 % when tested in accordance with ISO 16900-13 and ISO 16900-5 using the performance regimes escape specified in 7.2.10.

Number of samples, pre-conditioning and prerequisites are specified in 7.2.10.

7.2.10.2 Filtering escape RPD

7.2.10.2.1 Performance of work of breathing / breathing resistance/elastance for unassisted filtering escape RPD

This subclause supersedes ISO 17420-2:2021, 6.3.1.

RPD shall meet the requirements for work of breathing / breathing resistance and elastance when tested according the performance regime escape at $\begin{pmatrix} 0 \\ 35 \\ -2 \end{pmatrix}$ °C and $\begin{pmatrix} +2 \\ -5 \\ 0 \end{pmatrix}$ °C. Two RPD shall be equilibrated at each specified test temperature and tested at a temperature of (22 ± 3) °C and (50 ± 25) % RH. Testing shall begin within one minute after removal from the temperature conditioning.

Performance regime escape designated flow rates escape given in Table 9.

a) 35 l/min for 2 min;

b) 65 l/min for 3 min;

c) 35 l/min for 7 min;

d) 10 l/min for 3 min.

Table 9 — Setting of breathing machine for performance regime escape

Designated flow rate escape l/min	**Frequency** cycles/min	**Tidal volume** l
65 (with a tolerance of ±2 %)	32,5	2,0
35 (with a tolerance of ±2 %)	23,3	1,5
10 (with a tolerance of ±3 %)	10	1

The transition period between one flow rate and the next flow rate shall be no more than one minute including the stabilisation whilst the RPD remains in the operational mode.

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

The measurements shall begin after the stabilization of each step.

The work of breathing, breathing resistance, and elastance calculated from the average pressure volume loop based on ten consecutive breaths shall not exceed the limits shown in Table 10.

Table 10 — Limits of work of breathing, breathing resistance (peak pressure) and elastance

Designated flow rate escape (dynamic sinusoidal)	**Work of Breathing Limit** (WoB/V_T)		**Breathing resistance** (Peak pressures)		**Elastance**
	Inhalation	Exhalation	Inhalation	Exhalation	
l/min	kPa		kPa		kPa/l
65 (with a tolerance of ±2 %)	1,6	1,6	-2,0	2,0	1,0
35 (with a tolerance of ±2 %)	0,9	0,9	-1,2	1,2	1,0
10 (with a tolerance of ±3 %)	0,9	0,9	-1,2	1,2	1,0

One pre-conditioned RPD for each size shall be tested on the RPD headform based on the size as designated by the manufacturer. If the RPD is designated for all sizes, all the headforms or mouthpiece fixation, whatever is applicable, shall be used.

Test in accordance with ISO 16900-5 and ISO 16900-12.

7.2.10.2.2 Performance of work of breathing / breathing resistance/elastance for assisted filtering escape RPD

This subclause supersedes ISO 17420-2:2021, 6.3.2.

Two pre-conditioned RPD shall be tested in accordance with the performance regime escape as given below and meet the requirements given in Table 10 of each flow rate step at dynamic, sinusoidal flow pattern.

Performance regime escape designated flow rates escape

a) 35 l/min for 2 min;

b) 65 l/min for 3 min;

c) 35 l/min for 7 min;

d) 10 l/min for 3 min;

e) repeat steps a) through d) above until the test termination point.

The performance regime for assisted Escape RPD shall be performed at $\begin{pmatrix} -5 \\ 0 \end{pmatrix}^{+2}$ °C and $\begin{pmatrix} 35 \\ -2 \end{pmatrix}^{0}$ °C.

Perform the regime at least two cycles.

If the termination point (e.g. end of service life of battery) does not allow to complete step c) and d), at least once, the test shall be terminated and a separate 10 l/min test shall be performed for the duration as indicated by the termination point.

If the termination point has been reached after step b) (5 min) the separate 10 l/min-test shall be performed for 5 min.

With the exception of this change all other requirements of 7.2.10.2.2 shall apply.

Test in accordance with ISO16900-8, ISO 16900-5 and ISO 16900-12.

7.2.10.3 CO_2 concentration limits

7.2.10.3.1 CO_2 concentration limits for assisted filtering escape RPD

This subclause supersedes ISO 17420-2:2021, 6.4.1.

One escape filtering RPD for each size, in non pre-conditioned state, shall be tested on the RPD headform based on the size as designated by the manufacturer. If the RPD is designated for all sizes, all the headforms shall be used.

Escape filtering RPD in non pre-conditioned state shall meet the requirements when tested at ambient temperature when adjusted to the minimum design flow as determined in ISO 16900-8.

When tested at the performance regime escape as specified in 7.2.10.2.2, for the first step of the performance regime for 2 min the CO_2 concentration of the inhaled air shall not exceed 3 %.

For the second step of the performance regime for 3 min the CO_2 concentration of the inhaled air shall not exceed an average of 2 % over the 3 min and shall not exceed 3 % at any time.

For the third step of the performance regime for 7 min the CO_2 concentration of the inhaled air shall not exceed an average of 2 % over the 7 min and shall not exceed 3 % at any time.

For the fourth step of the performance regime for 3 min the CO_2 concentration of the inhaled air shall not exceed an average of 2,5 % over the 3 min and shall not exceed 3% at any time.

In case that the regime has to be repeated according to the duration of the RPD, the limits for the first step for 2 min the CO_2 concentration of the inhaled air shall not exceed an average of 2 % over the 2 min and shall not exceed 3 % at any time.

The CO_2 concentration of the inhalation air shall not exceed the limits given above after correction by subtraction of the ambient CO_2-level in the laboratory.

After testing the test shall be continued for one cycle of the performance regime escape in the power off mode.

For the power-off mode the same CO_2 limits shall apply.

At the end of each exhalation cycle the exhaled air shall contain 5,3 % CO_2

Testing shall be performed in accordance with ISO 16900-8 and ISO 16900-9.

7.2.10.3.2 CO_2 concentration limits for unassisted filtering escape RPD

This subclause supersedes ISO 17420-2:2021, 6.4.2.

One Escape RPD in non pre-conditioned state, for each size shall be tested on the RPD headform based on the size as designated by the manufacturer. If the RPD is designated for all sizes, all the headforms shall be used.

Escape filtering RPD in non pre-conditioned state shall meet the requirements when tested at ambient temperature.

When tested at the performance regime escape as specified in 7.2.10.2.1, for the first step of the performance regime for 2 min the CO_2 concentration of the inhaled air shall not exceed 3 %.

For the second step of the performance regime for 3 min the CO_2 concentration of the inhaled air shall not exceed an average of 2 % over the 3 min and shall not exceed 3 % at any time.

For the third step of the performance regime for 7 min the CO_2 concentration of the inhaled air shall not exceed an average of 2 % over the 7 min and shall not exceed 3 % at any time.

For the fourth step of the performance regime for 3 min the CO_2 concentration of the inhaled air shall not exceed an average of 2,5 % over the 3 min and shall not exceed 3 % at any time.

In case that the regime has to be repeated according to the duration of the RPD, the limits for the first step for 2 min the CO_2 concentration of the inhaled air shall not exceed an average of 2 % over the 2 min and shall not exceed 3 % at any time.

The CO_2 concentration of the inhalation air shall not exceed the limits given above after correction by subtraction of the ambient CO_2-level in the laboratory.

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.

7.2.10.4 Donning - Filtering escape RPD and supplied breathable gas escape RPD

This subclause supersedes ISO 17420-1:2021, 5.8.2.

Escape-only RPD in non pre-conditioned state and in its ready-for-use state shall be capable of being donned by the wearer, without assistance; within 30 s following the information supplied by the manufacturer and shall be donned in the dark.

Testing shall be performed in accordance with 16900-7.

7.2.10.5 Classes supplied breathable gas escape RPD

7.2.10.5.1 Supplied breathable gas escape general RPD

Supplied breathable gas escape general RPD designated as ES(*t*) RPD shall meet the requirements of ISO 17420-4:2021, Clause 6, except

— ISO 17420-4:2021, 6.2;

— ISO 17420-4:2021, 6.4;

— ISO 17420-4:2021, 6.5;

— ISO 17420-4:2021, 6.13.3.3.

The performance of work of breathing, breathing resistance, elastance and CO_2, O_2 and temperature and humidity of inhaled gas shall meet the requirements of 7.2.10.

Supplied breathable gas escape RPD shall have a minimum protection class of PC3 and shall perform at the designated flow rates for escape.

7.2.10.5.2 Escape from fire RPD

Escape from fire RPD designated as ES FF(*t*) shall meet the requirements of ISO 17420-4:2021, Clause 6, except

— ISO 17420-4:2021, 6.2;

— ISO 17420-4:2021, 6.13.3.3.

The performance of work of breathing, breathing resistance, elastance, CO_2, O_2 and temperature and humidity of inhaled gas shall meet the requirements of 7.2.10.

Escape from fire RPD shall have a minimum protection class of PC3 and shall perform at the designated flow rates for escape.

7.2.10.5.3 Mining escape RPD

Mining escape RPD designated as ES MN(*t*) shall meet the requirements of ISO 17420-4:2021, Clause 6 except

— ISO 17420-4:2021, 6.2;

— ISO 17420-4:2021, 6.13.3.3.

The performance of work of breathing, breathing resistance, elastance, CO_2, O_2 and temperature and humidity of inhaled gas shall meet the requirements of 7.2.10.

Mining escape shall have a minimum protection class of PC3 and shall perform at the designated flow rates for escape.

7.2.10.5.4 Marine escape RPD

Marine escape RPD shall meet the requirements of ISO 17420-4:2021, Clause 6 except

— ISO 17420-4:2021, 6.2;

— ISO 17420-4:2021, 6.13.3.3.

The performance of work of breathing, breathing resistance, elastance, CO_2, O_2 and temperature and humidity of inhaled gas shall meet the requirements of 7.2.10.

Marine escape shall have a minimum protection class of PC3 and shall perform at the designated flow rates for escape.

7.2.10.6 Classes escape filtering RPD

7.2.10.6.1 Filtering escape general RPD

RPD designated as ES xx(*t*) shall meet the requirements of ISO 17420-1:2021, 5.1, 5.2, 5.3, 5.4, 5.7, 5.8 (except 5.8.3) and 5.9.1.1.

RPD designated as ES xx(*t*) shall have a minimum protection class of PC3 and shall perform at the designated flow rate for the class escape general RPD.

When one filter of a multiple filter device is tested separately, the flow specified for a test shall be divided by the number of filters through which the flow is proportioned. If, however, it is possible that one filter of a multiple filter device may be used alone, then the full flow rate shall be used for testing.

Combination filters shall have the particle filter on the inlet side of the filter as used.

Filters shall meet the minimum breakthrough time (*t*) for their specific test gas(es) at the given breakthrough concentration given in Tables 11 and 12.

Prior to this performance RPD whose air management allows the wearer's exhaled air to pass through the gas and combination filters of escape RPD with the class t > 30 min shall be pre-conditioned in accordance with ISO 17420-2:2021, 6.9.3.1 but the exposure time in relation to class t with a tolerance of +10/0 min.

Table 11 — Filter requirement for class escape general

Type	Test gas concentration	Flow rate	Temperature	Relative humidity	Breakthrough concentration	Minimum breakthrough time
	ml/m³	l/min (with a tolerance of ±2 %)	°C	%	ml/m³	min
OV	Organic vapour[a] (Cyclohexane)					
	1 000	30	(22 ± 1)	(25 ± 3) and (70 ± 3)	10	t
OG	Organic gas and vapour low boiling[b] Dimethylether					
	300	30	(22 ± 1)	(25 ± 3) and (70 ± 3)	10	t
	Isobutane					
	3 000	30	(22 ± 1)	(25 ± 3) and (70 ± 3)	10	t

[a] Organic compound having a boiling point >65°C at atmospheric pressure.

[b] Organic compound having a boiling point ≤65°C at atmospheric pressure.

[c] Any of NO, NO_2 and N_2O_4 may be present in effluent air. The total concentration of (NO + NO_2 + N_2O_4) shall not exceed 5 ml/m³; there is no distinction in measurement for the different effluents necessary.

[d] This concentration of Hg is the saturated vapour pressure at the test temperature.

[e] Both HCN and $(CN)_2$ may be present in effluent air. The total concentration of HCN and $(CN)_2$ shall not exceed 5ml/m³.

Table 11 *(continued)*

AC	Acidic gases $SO_2/Cl_2/H_2S$					
	1 000	30	(22 ± 1)	(25 ± 3) and (70 ± 3)	5	t
BC	Basic gases (NH_3)					
	1 000	30	(22 ± 1)	(25 ± 3) and (70 ± 3)	10	t
NOX	Nitrogen monoxide (NO)					
	1 000	30	(22 ± 1)	(25 ± 3) and (70 ± 3)	5[c]	t
	Nitrogen dioxide (NO_2)					
	1 000	30	(22 ± 1)	(25 ± 3) and (70 ± 3)	5[c]	t
HG	Mercury (Hg)					
	1,9[d]	30	(22 ± 1)	(25 ± 3) and (70 ± 3)	0,012	t
HCN	Hydrogen Cyanide (HCN)					
	1000	30	(22 ± 1)	(25 ± 3) and (70 ± 3)	5 [e]	t
AH	Arsine (AsH_3)					
	1	30	(22 ± 1)	(25 ± 3) and (70 ± 3)	0,1	t
HF	Hydrogen Fluoride (HF)					
	70	30	(22 ± 1)	(25 ± 3) and (70 ± 3)	3	t
CD	Chlorine dioxide (ClO_2)					
	500	30	(22 ± 1)	(25 ± 3) and (70 ± 3)	0,1	t
ETO	Ethylen Oxide ($(CH_2)_2O$)					
	300	30	(22 ± 1)	(25 ± 3) and (70 ± 3)	1	t
FM	Formaldehyde (CH_20)					
	100	30	(22 ± 1)	(25 ± 3) and (70 ± 3)	1	t
MB	Methylbromide (CH_3Br)					
	1000	30	(22 ± 1)	(25 ± 3) and (70 ± 3)	1	t
PH	Phosphine (PH_3)					
	300	30	(22 ± 1)	(25 ± 3) and (70 ± 3)	0,3	t

[a] Organic compound having a boiling point >65°C at atmospheric pressure.

[b] Organic compound having a boiling point ≤65°C at atmospheric pressure.

[c] Any of NO, NO_2 and N_2O_4 may be present in effluent air. The total concentration of ($NO + NO_2 + N_2O_4$) shall not exceed 5 ml/m^3; there is no distinction in measurement for the different effluents necessary.

[d] This concentration of Hg is the saturated vapour pressure at the test temperature.

[e] Both HCN and $(CN)_2$ may be present in effluent air. The total concentration of HCN and $(CN)_2$ shall not exceed 5ml/m^3.

RPD designated as ES CO(*t*) shall meet the requirements of ISO 17420-1:2021, 5.1, 5.2, 5.3, 5.4, 5.7, 5.8 (except 5.8.3) and 5.9.1.1.

RPD designated as ES CO(*t*) shall have a minimum protection class of PC3 and shall perform at the designated flow rate for the class escape general RPD.

Filter(s) to be used in class escape CO(*t*) shall meet the requirements given in Table 12.

Table 12 — Filter requirement for class escape CO

Type/ class	Test gas concentration	Flow rate		Temperature	Relative humidity	Breakthrough concentration	Minimum breakthrough time
		(dynamic)[a]	(constant)				
	ml/m³	l/min (with a tolerance of ±2 %)		°C	%	ml/m³	min
ES CO(*t*)	3 000	35	—	(25 ± 1)	(95 ± 3)	200[b] and 200 ml dose	t
	9 000	35	—	(25 ± 1)	(95 ± 3)		t
	3 000	—	110	(5 ± 1)	NA		t

[a] Testing as complete filtering RPD.

[b] Time weighted average over any 5 min interval (moving average, where applicable).

7.2.10.6.2 Escape from fire

RPD designated as ES FF(*t*) shall meet the requirements of ISO 17420-1:2021, 5.1, 5.2, 5.3, 5.4, 5.7, 5.8 (except 5.8.3) and 5.9.1.1.

RPD designated as ES FF(*t*) shall have a minimum protection class of PC3 and shall perform at the designated flow rate for the class escape general RPD.

When one filter of a multiple filter device is tested separately, the flow specified for a test shall be divided by the number of filters through which the flow is proportioned. If, however, it is possible that one filter of a multiple filter device may be used alone, then the full flow rate shall be used for testing.

Combination filters shall have the particle filter on the inlet side of the filter as used.

Filters shall meet the minimum breakthrough time, *t*, for their specific test gas(es) at the given breakthrough concentration given in Table 13.

Prior to this performance RPD whose air management allows the wearer's exhaled air to pass through the gas and combination filters of escape RPD with the class t >30 min shall be pre-conditioned in accordance with ISO 17420-2:2021, 6.9.3.1 but the exposure time in relation to class t with a tolerance of +10/0 min.

Temperature of the inhaled air shall be as given in Figure 2, key 1.

Table 13 — Filter specification for class escape from fire

Class	Test agent	Challenge concentration ml/m³	Breakthrough concentration ml/m³	Minimum breakthrough time min	Temperature °C	Relative humidity %	Test flow rate l/min (with a tolerance of ±2%
ES FF(t)	Cyclohexane	500	5	t	(22 ± 1)	(25 ± 3) and (70 ± 3)	30[c]
	Acrolein	100	0,5	t	(22 ± 1)		30[c]
	Hydrogen chloride	1 000	5	t	(22 ± 1)		30[c]
	Sulfur dioxide	200	5	t	(22 ± 1)		30[c]
	Hydrogen cyanide	300	10[a]	t	(22 ± 1)		30[c]
	Carbon monoxide	3 000	200[b] and 200 ml dose	t	(5 ± 1)	NA	30[c]
	Carbon monoxide	3 000	200[b] and 200 ml dose	t	(25 ± 1)	(25 ± 3) and (70 ± 3)	35[d]
	Carbon monoxide	9 000	200[b] and 200 ml dose	t	(25 ± 1)		35[d]
	Sodium chloride	Class F2 - Short term exposure test only					110[c]

a Total of HCN and C_2N_2.

b Time weighted average over any 5 min interval (moving average, where applicable).

c Constant.

d Dynamic.

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

7.2.10.6.3 Escape mining

RPD designated as ES MN(*t*) shall meet the requirements of ISO 17420-1:2021, 5.1, 5.2, 5.3, 5.4, 5.7, 5.8 (except 5.8.3) and 5.9.1.1.

RPD designated as ES MN(*t*) shall have a minimum protection class of PC3 and shall perform at the designated flow rate for the class escape general RPD.

Combination filters shall have the particle filter on the inlet side of the filter as used.

Filters shall meet the minimum breakthrough time, *t*, for their specific test gas(es) at the given breakthrough concentration given in Table 14.

Prior to this performance RPD whose air management allows the wearer's exhaled air to pass through the gas and combination filters of escape RPD with the class t > 30 min shall be pre-conditioned in accordance with ISO 17420-2:2021, 6.9.3.1 but the exposure time in relation to class t with a tolerance of +10/0 min**.**

Filters shall be tested as complete RPD, which shall be pre-conditioned in accordance with 7.3.6.2 and 7.3.2.1, and shall meet the requirements in Table 14.

7.2.10.7 Short time breakthrough test for gas filter(s) other than type CO

Filter(s) shall meet the minimum breakthrough time of 3 min for their specific test gas(es) at the given breakthrough concentration for its type under the test parameters provided in Table 11 and for all gases besides CO in Table 13 with the exception of the tolerance of the relative humidity to be extended to ±5 % and the exception that the breakthrough concentration is averaged over the 3 min testing time at a continuous flow rate of 180 l/min.

If the test gas concentration in Table 11 is above 1 000 ml/m^3, the test shall be conducted at 1 000 ml/m^3.

For filter(s) used in assisted filtering RPD the test flow rate is the measured maximum flow rate as determined in accordance with ISO 16900-8 by setting the breathing machine to 65 l/min dynamic.

As an alternative to a test conducted at flow rates at 180 l/min or greater the breakthrough time may be calculated from measured breakthrough times at lower flow rates in accordance with the method described in ISO 16900-4:2011, Annex B. This method only applies to filter types OV, OG, AC and BC.

7.2.10.8 Short time breakthrough test for gas filter(s) type CO

Filter(s) shall meet the minimum breakthrough time of 3 min at the given breakthrough concentration for its type under the test parameters provided in Table 12, Table 13 only for CO and Table 14 with the exception of the tolerance of the relative humidity to be extended to ±5 % and the exception that the breakthrough concentration is averaged over the 3 min testing time. The complete filtering RPD shall be tested with a setting of the breathing machine at 65 l/min dynamic in accordance with Table 9. Testing shall be performed at the CO test gas concentration of 3 000 ml/m^3.

Assisted filtering RPD shall be tested at the maximum flow setting, if applicable.

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