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

Part 13:

**RPD using regenerated breathable
gas and special application mining
escape RPD: Consolidated test for gas
concentration, temperature, humidity,
work of breathing, breathing
resistance, elastance and duration**

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

*Partie 13: Appareils de protection respiratoire utilisant du gaz
respirable et appareils de protection respiratoire pour application
spéciale d'échappatoire minière: essai de consolidation pour
concentration de gaz, température, humidité, travail respiratoire,
résistance respiratoire et durée*



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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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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#).

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

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

- *Part 1: Determination of inward leakage*
- *Part 2: Determination of breathing resistance*
- *Part 3: Determination of particle filter penetration*
- *Part 4: Determination of gas filter capacity and migration, desorption and carbon monoxide dynamic testing*
- *Part 5: Breathing machine, metabolic simulator, RPD headforms and torso, tools and verification tools*
- *Part 6: Mechanical resistance/strength of components and connections*
- *Part 7: Practical performance tests methods*
- *Part 8: Measurement of RPD air flow rates of assisted filtering RPD*
- *Part 9: Determination of carbon dioxide content of the inhaled air*
- *Part 10: Resistance to ignition, flame, radiant heat and heat*
- *Part 11: Determination of field of vision*
- *Part 12: Determination of volume-averaged work of breathing and peak respiratory pressures*
- *Part 13: RPD using regenerated breathable gas and special application mining escape RPD: Consolidated test for gas concentration, temperature, humidity, work of breathing, breathing resistance, elastance and duration*

— *Part 14: Measurement of sound level*

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Introduction

This part of ISO 16900 is intended as a supplement to the respiratory protective devices (RPD) performance standards. Test methods are specified for complete devices or parts of devices that are intended to comply with the performance standards.

The following definitions apply in understanding how to implement an ISO International Standard and other normative ISO deliverables (TS, PAS, IWA):

- “shall” indicates a requirement;
- “should” indicates a recommendation;
- “may” is used to indicate that something is permitted;
- “can” is used to indicate that something is possible, for example, that an organization or individual is able to do something.

3.3.1 of the ISO/IEC Directives, Part 2 (sixth edition, 2011) defines a requirement as an “expression in the content of a document conveying criteria to be fulfilled if compliance with the document is to be claimed and from which no deviation is permitted.”

3.3.2 of the ISO/IEC Directives, Part 2 (sixth edition, 2011) defines a recommendation as an “expression in the content of a document conveying that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required, or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.”

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Respiratory protective devices — Methods of test and test equipment —

Part 13:

RPD using regenerated breathable gas and special application mining escape RPD: Consolidated test for gas concentration, temperature, humidity, work of breathing, breathing resistance, elastance and duration

1 Scope

This part of ISO 16900 specifies tests which are specific to RPDs using regenerated breathable gas, compressed breathable gas with class L respiratory interfaces, and special application mining escape RPD.

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 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 — Terms, definitions, graphical symbols and units of measurement*

3 Terms and definitions

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

3.1

class Sxxxx RPD

supplied breathable gas RPD, where Sxxxx equals the amount of breathable gas available for respiration in litres

3.2

body temperature pressure saturated BTPS

standard condition for the expression of ventilation parameters

Note 1 to entry: Body temperature (37 °C), atmospheric pressure 101,3 kPa (760 mmHg), and water vapour pressure (6,27 kPa) in saturated air.

3.3

standard temperature pressure dry STPD

standard conditions for expression of oxygen consumption

Note 1 to entry: Standard temperature (0 °C) and pressure (101,3 kPa, 760 mmHg), dry air (0 % relative humidity).

3.4

capacity

volume of available breathable gas of an RPD

4 Prerequisites

The performance standards shall indicate the conditions of the test. This includes the following:

- number of specimens;
- operating conditions of the RPD;
- the types of support such as RPD headform/fixation;
- any prior conditioning or testing;
- work rate class;
- temperature(s) at which tests are to be performed;
- any deviations from the test method(s).

5 General test requirements

Unless otherwise specified, the values stated in this part of ISO 16900 are expressed as nominal values. Except for temperature limits, values which are not stated as maxima or minima shall be subject to a tolerance of ± 5 %. Unless otherwise specified, the ambient conditions for testing shall be between 16 °C and 32 °C and (50 ± 30) % relative humidity. Any temperature limits specified shall be subject to an accuracy of ± 1 °C.

Where the assessment of the pass/fail criterion depends on a measurement, an uncertainty of measurement as specified in [Annex A](#) shall be reported.

The startup process for the RPD shall follow the information supplied by the manufacturer.

6 Test of RPD performance at work rate

6.1 General

RPD cylinders shall be charged to working pressure before testing (if applicable).

RPD shall be equilibrated and tested at each specified test temperature.

The following parameters shall be determined:

- work of breathing/breathing resistance, see [6.4.1](#);
- elastance, see [6.4.2](#);
- CO₂ concentration limits, see [6.5.2](#);
- oxygen content of RPD using regenerated breathable gas, see [6.5.3.1](#);
- oxygen content of RPD using oxygen enriched breathable gas, see [6.5.3.2](#);
- temperature and humidity of inspired breathable gas for regenerated breathable gas RPD and oxygen enriched breathable gas RPD, see [6.6](#);
- capacity.

For RPD that protect against carbon monoxide, the carbon monoxide content of the inspired gas shall be determined in accordance with 6.7.

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

The settings for the metabolic simulator for each flow rate are given in Table 1.

Table 1 — Settings for metabolic simulator for each flow rate

Flow rate (dynamic sinusoidal)	Breathing frequency	Tidal volume	O ₂ consumption rate	CO ₂ injection rate
l/min (BTPS) ^a	cycles/min	l (BTPS)	l/min (STPD) ^a	l/min (STPD)
10 (±3 %)	10,0	1,0	0,31	0,26
35 (±2 %)	23,3	1,5	1,09	0,91
65 (±2 %)	32,5	2,0	2,03	1,82
105 (±2 %)	42,0	2,5	3,28	3,57
135 (±1 %)	45,0	3,0	4,22	4,59

^a The values in Table 1 are given at BTPS and STPD, because values at BTPS reflect the conditions of the human, while STPD is used for settings of laboratory equipment.

6.2 Test regimes

6.2.1 General

RPD shall be tested to the test regime which is in accordance with the designated work rate class.

The transition period between one work rate and the next work rate shall be no more than one minute while 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 allowed for those types of RPD using enriched or generated oxygen.

For all RPD using control means, the test shall be performed both with the operating setting of the RPD adjusted to the maximum and the minimum flow conditions as specified by the manufacturer.

Testing shall be performed on the appropriate required headform.

Humidity and temperature of the exhaled gas shall be as required by the performance requirements.

6.2.2 Regime for RPD of class W1

- a) 35 l/min for 10 min
- b) 10 l/min for 5 min

Repeat steps a and b above until the test termination point is reached.

The RPD shall have enough capacity to complete step a at least once. It is not required to complete all of step b if the test termination point is reached.

6.2.3 Regime for RPD of class W2

- a) 35 l/min for 5 min
- b) 65 l/min for 5 min

- c) 10 l/min for 5 min

Repeat steps a through c above until the test termination point is reached.

The RPD shall have enough capacity to complete steps a and b at least once. It is not required to complete all of step c if the test termination point is reached.

6.2.4 Regime for RPD of class 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

Repeat steps a through d above until the test termination point is reached.

The RPD shall have enough capacity to complete steps a, b, and c at least once. It is not required to complete all of step d if the test termination point is reached.

6.2.5 Regime for RPD of class 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

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Repeat steps a through e above until the test termination point is reached

The RPD shall have enough capacity to complete steps a, b, c, and d at least once. It is not required to complete all of step e if the test termination point is reached.

6.3 Determination of capacity of class Sxxxx RPD

6.3.1 Class Sxxxx RPD — having class L respiratory interfaces using compressed breathable gas

RPD shall be equilibrated at each specified test temperature and tested at ambient temperature, according to the work rate specified by the manufacturer. The determination of the capacity shall be performed at settings specified in [Table 2](#).

Table 2 — Breathing machine settings for capacity tests

Work rate class	Flow rate (dynamic sinusoidal) l/min (BTPS)	Tidal volume l (BTPS)	Frequency cycles/min
W1	30 ± 2 %	1,5	20,0
W2	40 ± 2 %	2,0	20,0
W3	50 ± 2 %	2,0	25,0
W4	65 ± 2 %	2,0	32,5

Capacity for RPD is the usable breathable gas volume down to 2,0 MPa.

The capacity shall be determined by the lowest result.

Capacity is designated in litres rounded down to increments of 150 l up to 900 l and increments of 300 l above 900 l.

6.3.2 Class Sxxxx RPD — not using compressed breathable gas

RPD shall be evaluated as listed below when tested according to the table below. At least one RPD shall be equilibrated at each specified test temperature and tested at ambient temperature, according to the work rate specified by the manufacturer. The determination of the capacity shall be performed at settings described in [Table 3](#).

Table 3 — Metabolic simulator settings for capacity

Work rate class	Flow rate (dynamic sinusoidal) l/min (BTPS)	Tidal volume l (BTPS)	Frequency cycles/min	O ₂ consumption rate l/min (STPD)	CO ₂ injection rate l/min (STPD)
W1	30 (±2 %)	1,5	20,0	0,93	0,78
W2	40 (±2 %)	2,0	20,0	1,24	1,05
W3	50 (±2 %)	2,0	25,0	1,55	1,35
W4	65 (±2 %)	2,0	32,5	2,03	1,82

Capacity is the usable breathable gas supplied by the RPD until the performance limits in performance standard are no longer met.

The capacity shall be determined by the lowest result.

Capacity is designated in litres rounded down to increments of 150 l up to 900 l and increments of 300 l above 900 l.

6.4 Volume averaged work of breathing, pressures and elastance

6.4.1 Work of breathing/breathing resistance (peak pressures)

RPD work of breathing and breathing resistance (peak pressures) shall be determined in each cycle of each step of the test regime for the designated work rate class, specified in [6.2](#).

The measurements shall begin after the stabilization of each step.

The average of any 10 consecutive determinations shall be reported.

Testing shall be performed in accordance with ISO 16900-12 and the relevant regimes specified in [6.2.2](#) to [6.2.5](#).

6.4.2 Elastance

RPD elastance shall be determined in each cycle of each step of the test regime for the designated work rate class, specified in [6.2](#). The measurements shall start after the stabilization of each step.

The average of any 10 consecutive determinations shall be reported.

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