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Respiratory protective devices — Methods of test and test equipment —

Part 6: Mechanical resistance/strength of components and connections

Appareils de protection respiratoire — Méthodes d'essai et équipement d'essai —
Partie 6: Résistance mécanique — Résistance des composants

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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. www.iso.org/directives

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

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 test 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 heat, ignition, flame, radiant heat and heat*
- *Part 11: Determination of field of vision*
- *Part 12: Determination of volume-averaged work of breathing and peak respiratory pressures*
- *Part 13: RPD using regenerated breathable gas and special application mining escape RPD; Consolidated test for gas concentration, temperature, humidity, work of breathing, breathing resistance, elastance and duration*
- *Part 14: Measurement of sound level*

Introduction

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

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.

ISO/IEC Directives, Part 2 (sixth edition, 2011), 3.3.1 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.”

ISO/IEC Directives, Part 2 (sixth edition, 2011), 3.3.2 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.”

Respiratory protective devices — Methods of test and test equipment —

Part 6: Mechanical resistance/strength of components and connections

1 Scope

This part of ISO 16900 specifies the method of test for the mechanical resistance and strength of components of respiratory protective devices.

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 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
ready for assembly state
components with seals, plugs or other environmental protective means, if applicable, still in place

3.2
ready for use state
state of the complete, but not necessarily fully assembled RPD, which allows the immediate start of the donning procedure as described by the manufacturer

4 Prerequisites

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

— Test method(s) to be used (reference taken from Table 1).

— Number of specimens.

— Status of samples or specimen for testing, e.g. preconditioned, as received, ready for use state.

— Any deviations from the test methods.

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.

6 Test methods

6.1 General

Nine test methods are described hereafter, some including levels. These are referenced in Table 1 and the reference is a part of the prerequisite. Any deviations from the methods shall be cited in the test report.

Table 1 — Test methods

Reference	Test method title
6.2	Resistance of hoses to deformation, via compressive load
6.3	Flexibility of medium pressure hoses, via bending
6.4[a]	Flexibility of high pressure hoses, via bending
6.5	Coil kinking of hoses greater than 10 m in length
6.6[a]	Corner kinking for hoses greater than two metres and up to and including 10 m in length
6.7	Shock resistance for filters
6.8	Mechanical stress resistance
6.9	Strength of visor
6.10	Strength of connections

[a] Handling components under high pressure requires safety precautions.

6.2 Resistance of hoses to deformation, via compressive load

6.2.1 Principle

A compressive force or stress on a hose can reduce the gas flow to the wearer of the respiratory protective device. The objective of this test is to quantify any reduction of the gas flow rate through a hose utilized in a RPD caused by the application of a load or force.

6.2.2 Sample and apparatus

6.2.2.1 Hose sample, at least 200 mm long.

6.2.2.2 Two metal disks, at least 20 mm thick and (100 ± 5) mm in diameter each, with periphery edge radiused to R0,5. One of the disks shall be fixed and the other capable of moving only perpendicular to the plane of the disks. Additional means being capable of imposing a compressive load, as specified in Table 2, may be required.

6.2.2.3 Environmental chamber or **oven**, capable of maintaining an air temperature of $(35^{\ 0}_{-2})$ °C.

6.2.2.4 Source of breathable gas, at a pressure necessary to perform the test and capable of flowing gas through the hose sample at a rate of (110 ± 5) l/min.

6.2.2.5 Flow meter, capable of measuring the gas flow rate to the nearest 2 l/min.

6.2.2.6 **Flow restrictor/restriction**, capable of controlling the gas flow rate.

6.2.2.7 **Pressure controlling and measuring device**(s) , of appropriate range and precision.

6.2.3 Procedure

6.2.3.1 Place the hose sample and metal disks into the environmental chamber and equilibrate for at least 1 h, at (35^{0}_{-2}) °C.

6.2.3.2 Within 60 s of removing the hose sample and disks from the environmental chamber or oven:

— install disks in test apparatus;

— attach one end of the hose sample to the source of compressed gas;

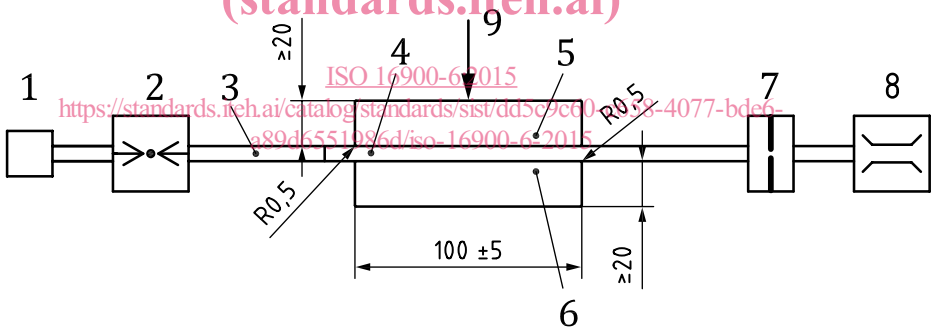
— attach the flow restrictor and flow meter to the “Open end” or effluent side of the hose sample;

— adjust the source of gas and flow restrictor to attain a gas flow rate of (110 ± 5) l/min, and specified gas pressure, if required in Table 2.

This flow rate shall be recorded as Q_{t1}.

6.2.3.3 Within 30 additional seconds, centre the hose sample between the metal disks, and apply, through the moving disk, the specified compressive load, as given in Table 2, to the hose sample. See Figure 1.

Dimensions in millimetres



Key

1	source of breathable gas	6	fixed lower metal disk (corners radiused to R0,5)
2	pressure controlling and measuring device	7	flow restrictor
3	straight	8	flow meter
4	hose sample	9	applied compressive load (see Table 2)
5	moveable upper metal disk (corners radiused to R0,5)		

Figure 1 — Typical arrangement for determining the resistance of hoses to deformation, via compression

6.2.3.4 (60 ± 5) s after the application of the specified compressive load, measure the gas flow rate through the hose. Record the flow rate as Q_{t2}. The supply pressure shall be the same before and during the application of the compressive load.

6.2.3.5 Calculate the percentage change in gas flow rate ($Q_{\%}$) as shown in Formula (1):

$$Q_{\%} = \frac{Q_{t1} - Q_{t2}}{Q_{t1}} \times 100 \quad (1)$$

where

Q_{t1} is the gas flow rate before the application of a compressive load;

Q_{t2} is the gas flow rate 1 min after the application of a compressive load.

Table 2 — Initial test conditions for resistance of hoses to deformation, via compressive load

Hose type	Gas flow rate l/min	Gas pressure within hose	Applied compressive load N
Low pressure hose	(110 ± 5)	n/a	(50 ± 2,5)
Medium and high pressure hose up to 10 m long	(110 ± 5)	Minimum pressure specified by manufacturer	(250 ± 12,5)
Medium and high pressure hose greater than 10 m long	(110 ± 5)	Minimum pressure specified by manufacturer	(1 000 ± 50)

6.2.4 Test report

The test report shall include information regarding those parameters specified in Clause 4, the pressure at which the test was conducted and the percentage change in the gas flow rate after the specified compressive load has been applied to the hose sample.

6.3 Flexibility of medium pressure hoses, via bending

6.3.1 Principle

A bending force placed on a hose can cause it to crack. The objective of this test is to determine if any cracking of a medium pressure hose, utilized in a supplied breathable gas respiratory protection device, occurs when it is bent through an angle of 180° after equilibration at −5 °C and tested immediately afterwards. Class SY RPD are tested at the extremes of the operating pressures.

6.3.2 Sample and apparatus

6.3.2.1 Hose sample, at least 300 mm long.

6.3.2.2 Rigid metallic cylinder, at least 100 mm long with (80 ± 4) mm diameter.

6.3.2.3 Environmental chamber, capable of maintaining an air temperature of (-5^{+2}_{0}) °C, and equipped with an inlet through for compressed gas.

6.3.2.4 Source of compressed gas, capable of pressurizing the hose sample.

6.3.2.5 Pressure controlling and measuring device(s), of appropriate range and precision.

6.3.2.6 Fixture, to support and align hose with respect to cylinder.

6.3.3 Procedure

6.3.3.1 Attach the inlet end of the hose sample to the source of compressed gas, and seal the "open end" or effluent side of the hose sample with an end cap.

6.3.3.2 Adjust the source of compressed gas to attain the manufacturer's maximum specified gas pressure.

6.3.3.3 Place at least 300 mm of the pressurized hose sample into the environmental conditioning chamber, making certain that a length of at least 300 mm is straight. The hose sample may be disconnected from the pressure source for this, provided the pressure is maintained inside the hose.

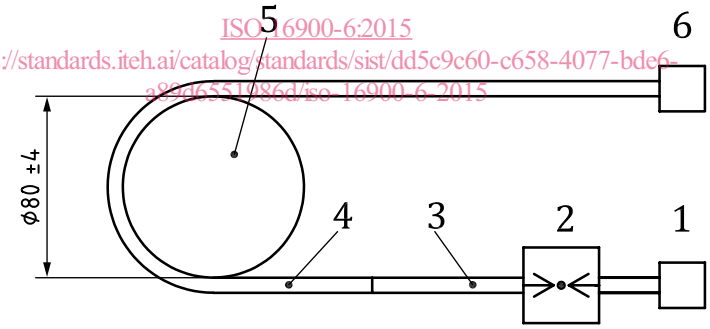
6.3.3.4 Equilibrate the hose sample, along with the metal cylinder for a minimum of 1 h at (-5^{+2}_{0}) °C.

6.3.3.5 Within 60 additional seconds of removing the hose sample from the environmental conditioning chamber, bend the section of the hose sample that was kept straight 180° around the metallic cylinder. The hose shall be in contact with the cylinder, as shown in Figure 2

6.3.3.6 Maintain the hose in this bent condition for (60^{+15}_{0}) s.

6.3.3.7 After completion of the test, release the pressure, remove the hose sample from the cylinder and examine the hose sample for cracks that are superficial, or that occur through the thickness of the hose. In addition, examine the hose sample for any exposure of braiding that forms part of the hose structure

Dimensions in millimetres



Key

1 source of compressed gas
2 pressure controlling and measuring device
3 straight metal tube
4 hose sample
5 metal cylinder
6 sealing end cap

Figure 2 — Typical arrangement for determining the resistance of a hose to cracking when bent through 180°

6.3.4 Test report

The test report shall include the test temperature and supply pressure and information regarding those parameters specified in Clause 4 along with any information or observations regarding the hose sample.

6.4 Flexibility of high pressure hoses, via bending

6.4.1 Principle

A bending force placed on a hose can deform it, causing it to crack. The objective of this test is to determine if any cracking of a high pressure hose, utilized in a supplied breathable gas respiratory protection device, occurs when it is bent through an angle of 90° after equilibration at −5 °C.

6.4.2 Sample and apparatus

6.4.2.1 **Hose sample**, at least 300 mm long.

6.4.2.2 **Rigid metallic cylinder**, at least 100 mm long with (80 ± 4) mm diameter.

6.4.2.3 **Environmental chamber**, capable of maintaining an air temperature of $(-5\,^{+2}_{0})$ °C.

6.4.2.4 **Source of compressed gas**.

6.4.2.5 **Pressure controlling and measuring device(s)**, of appropriate range and precision.

6.4.2.6 **Fixture**, to support and align hose with respect to cylinder.

6.4.3 Procedure

6.4.3.1 Attach the inlet end of the hose sample to the source of compressed gas, and seal the "Open end" or effluent side of the hose sample with an end cap.

6.4.3.2 Adjust the source of compressed gas to attain the manufacturer's maximum specified gas pressure.

6.4.3.3 Place at least 300 mm of the pressurized hose sample into the environmental conditioning chamber, making certain that a length of at least 300 mm is straight. The hose sample may be disconnected from the pressure source for this, provided the pressure is maintained inside the hose.

6.4.3.4 Equilibrate the hose sample, along with the metal cylinder for a minimum of 1 h, at $(-5\,^{+2}_{0})$ °C.

6.4.3.5 Within 60 additional seconds of removing the sample from the environmental conditioning chamber, bend the hose sample 90° around the metallic cylinder. See Figure 3.

6.4.3.6 Maintain the hose in this bent condition for $(60\,^{+15}_{0})$ s.

6.4.3.7 After completion of the test, release the pressure, remove the hose sample from the cylinder and examine the hose sample for fractures (superficial and through the thickness of the hose).