INTERNATIONAL STANDARD

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Second edition
2021-08

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 et des connexions

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

This second edition cancels and replaces the first edition (ISO 16900-6:2015), which has been technically revised. The main changes compared to the previous edition are as follows:

— changes have been made to the text and drawings in 6.7, 6.8, and 6.10;

— a new subclause regarding chemical resistance of materials has been added.

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

Respiratory protective devices — Methods of test and test equipment —

Part 6: Mechanical resistance/strength of components and connections

1 Scope

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

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

3 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 terminology databases for use in standardization at the following addresses:

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

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

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

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

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

For each of the required measurements performed in accordance with this document, a corresponding estimate of the uncertainty of measurement shall be evaluated. This estimate of uncertainty shall be stated when reporting test results, in order to enable the user of the test report to assess the reliability of the result in accordance with Annex A.

NOTE Uncertainty of measurement can be calculated in accordance with JCGM 100[1].

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
6.11	Chemical resistance of materials

[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 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 R 0,5. 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 may be required.

6.2.2.3 Environmental chamber or oven, capable of maintaining an air temperature of $\left(35_{-2}^{\ 0}\right)$ °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 Flowmeter, 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 $\left(35_{-2}^{\ 0}\right)$ °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;

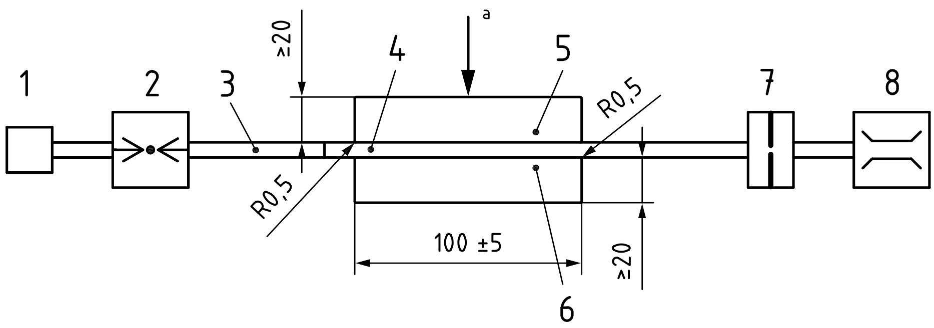
NOTE A flow restrictor cannot be necessary when testing low pressure hoses.

— 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 by the performance standard.

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

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

Dimensions in millimetres



Key

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

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

6.2.3.4 After (60 ± 5) s with the specified compressive load still applied, 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.

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.

6.3.2 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 $\left(-5^{+2}_{\ 0}\right)$ °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.

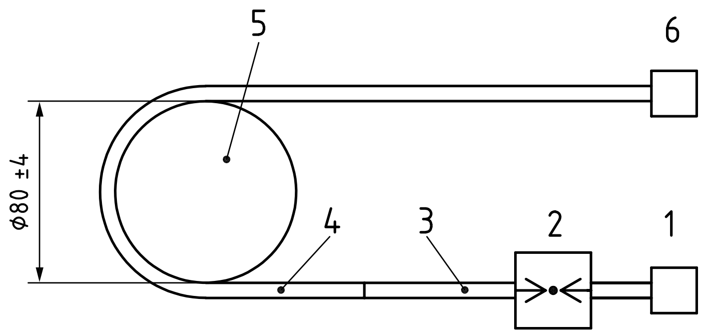
6.3.3.4 Equilibrate the hose sample and the metal cylinder for a minimum of 1 h at $\left(-5^{+2}_{\ 0}\right)$ °C.

6.3.3.5 Within an additional 60 s 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 $\left(65^{+15}_{\ \ 0}\right)$ s.

6.3.3.7 After completion of the test remove the hose sample from the cylinder. Examine the hose sample for cracks, which may be indicated by loss of pressure as well as through visual observation. Other possible signs of damage such as exposed braiding, bulging, ruptures, delamination, distortion or any other defect shall be reported.

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 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 $\left(-5^{+2}_{0}\right)$ °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.

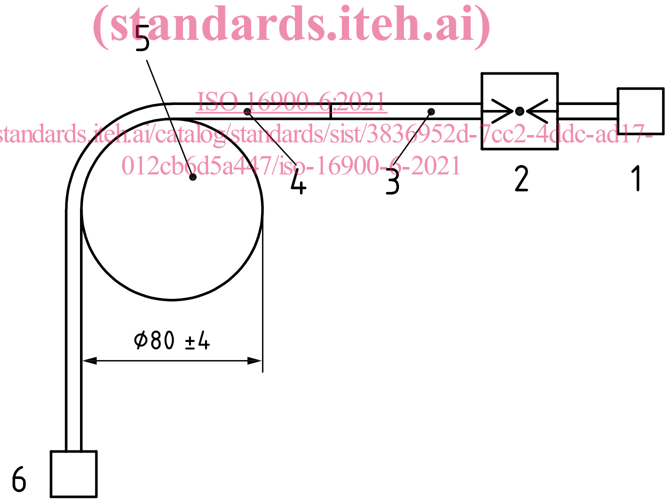
6.4.3.4 Equilibrate the hose sample and the metal cylinder for a minimum of 1 h, at $\left(-5^{+2}_{\ 0}\right)$ °C.

6.4.3.5 Within an additional 60 s of removing the sample from the environmental conditioning chamber, bend the hose sample 90° around the metallic cylinder. The hose shall be in contact with the cylinder as shown in Figure 3.

6.4.3.6 Maintain the hose in this bent condition for $\left(65^{+15}_{\ \ 0}\right)$ 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).

Dimensions in millimetres



Key

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

Figure 3 — Typical arrangement for determining the resistance of a hose to cracking when bent through 90°