INTERNATIONAL STANDARD

ISO 16900-6

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
ISO 16900-6:2021(E)

Contents

Page

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;

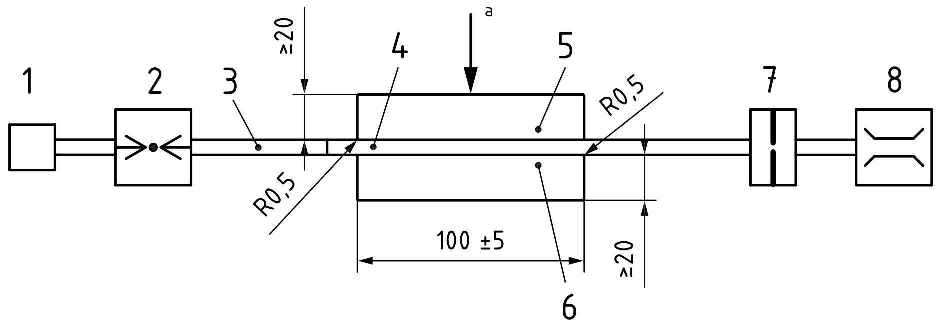
NOTE A flow restrictor cannot be necessary when testing low pressure hoses.

— 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.

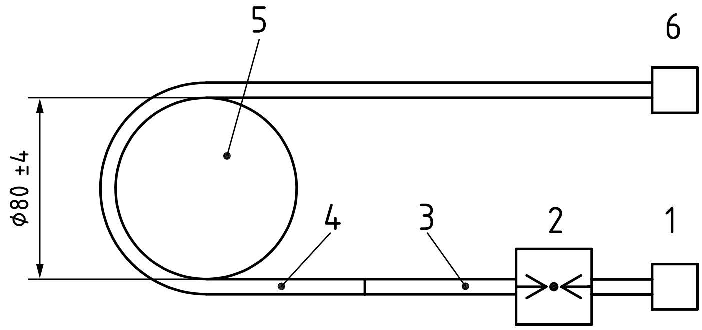
6.3.3.4 Equilibrate the hose sample and the metal cylinder for a minimum of 1 h at $\left(-5^{+2}_{\ 0}\right)$ °C.

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.

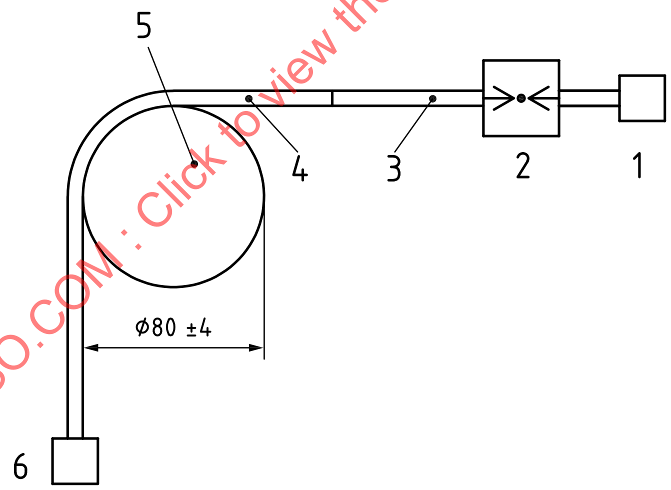
6.4.3.4 Equilibrate the hose sample and the metal cylinder for a minimum of 1 h, at $\left(-5^{+2}_{\ 0}\right)$ °C.

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°

6.4.4 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.

6.5 Coil kinking of hoses greater than 10 m in length

6.5.1 Principle

Kinking of a hose can deform it causing it to collapse, thus reducing the gas flow to the wearer of the RPD. The objective of this test is to quantify the reduction in the gas flow rate to the RPD when the hose, operating at the minimum supply pressure as specified by the manufacturer is looped and pulled straight.

6.5.2 Apparatus

6.5.2.1 Two hose samples, at least 1,5 m long.

6.5.2.2 Oven and/or **environmental chamber**, capable of maintaining an air temperature of $\left(-5^{+2}_{\ 0}\right)$ °C and $\left(35^{\ 0}_{-2}\right)$ °C, respectively.

6.5.2.3 Source of compressed gas, capable of flowing gas through the hose sample at the minimum pressure specified by the manufacturer of the respiratory protective device.

6.5.2.4 Flowmeter, of the appropriate range and precision.

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

6.5.2.6 Flow restrictor.

6.5.3 Procedure

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

6.5.3.2 Within 60 s of removing the hose sample from the environmental conditioning chamber,

— place the sample on a horizontal surface,

— attach one end of the sample to the source of compressed gas,

— attach the flow meter to the other end (“open end”) of the sample, and

— adjust the source of gas and flow restrictor to attain a gas flow of (110 ± 5) l/min at the manufacturer’s minimum supply pressure.

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

6.5.3.3 Within additional 30 s, bend the hose sample to create a loop having an inside diameter of approximately (300 ± 10) mm. See Figure 4.

6.5.3.4 Immediately after creating a loop, pull the ends of loop tangentially to the loop until the sample takes a form of a straight line. Continuously monitor the flow rate through the sample.

6.5.3.5 Record the minimum gas flow rate as Q_{t2}.

6.5.3.6 Calculate the percentage change in gas flow rate ($Q_{\%}$) as shown in Formula (2):

$$Q\% = \frac{Q_{t1} - Q_{t2}}{Q_{t1}} \times 100 \qquad (2)$$

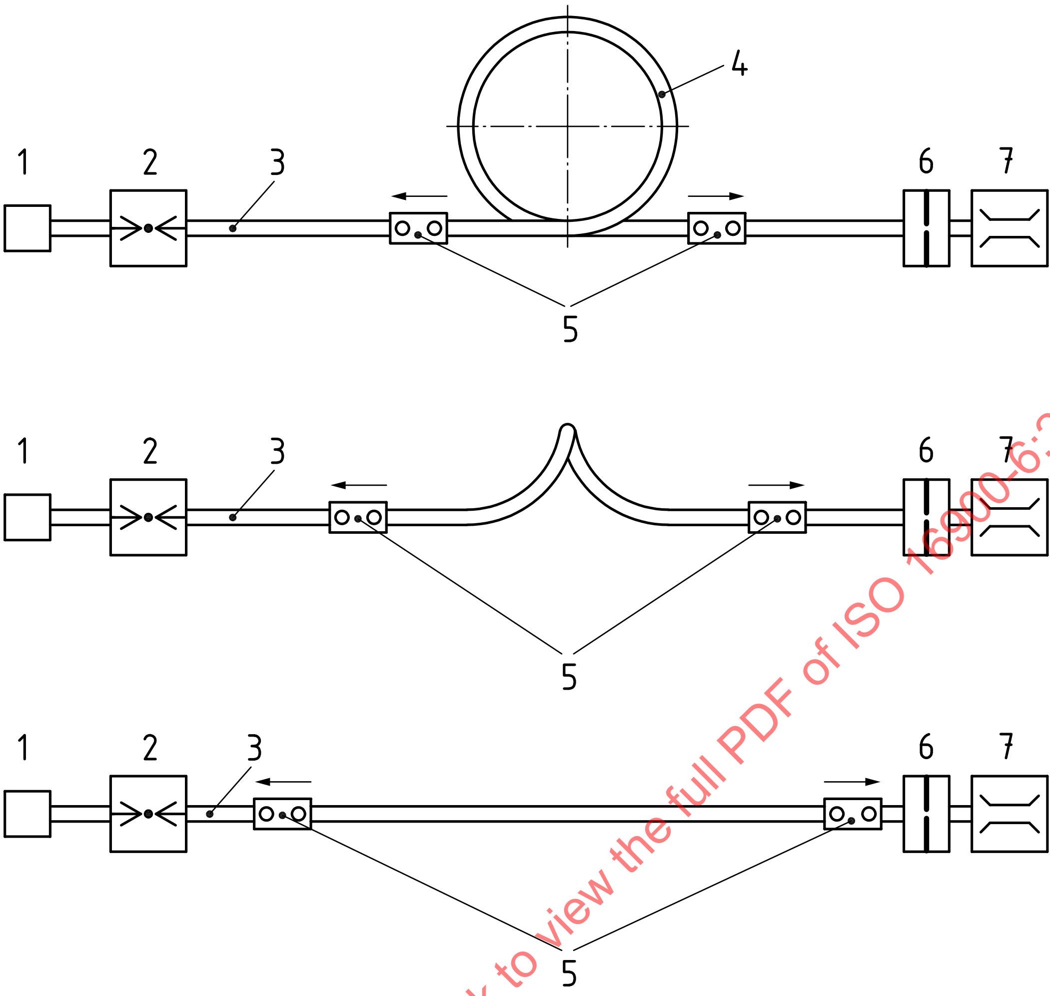
where

Q_{t1} is the gas flow rate before the bending of the hose;

Q_{t2} is the minimum rate of gas flow through the sample as it is looped, spiralled and pulled.

6.5.3.7 Repeat 6.5.3.1 to 6.5.3.6 on the same test sample with the hose looped in the opposite (clockwise or anti-clockwise) direction. See Figures 4 and 5. The whole test sequence 6.5.3.2 to 6.5.3.5 shall be completed within 5 min.

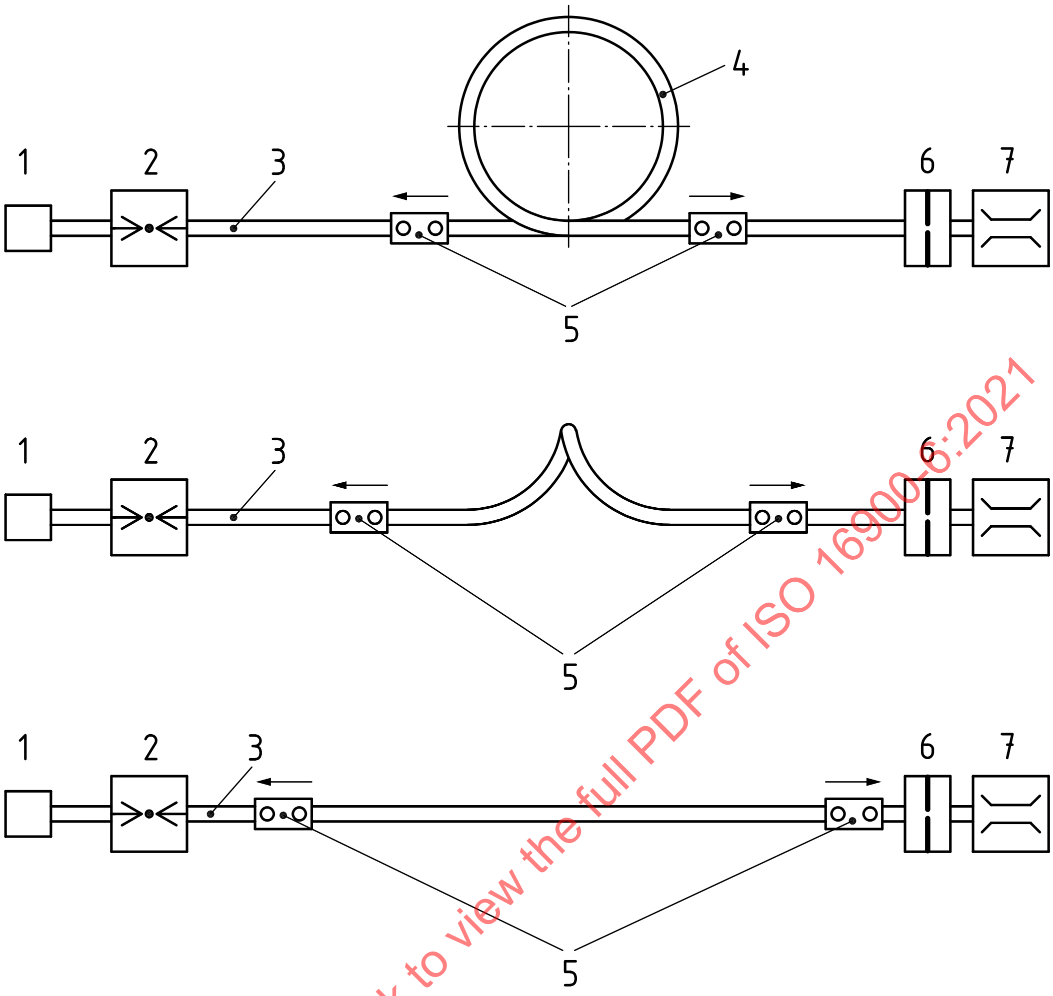
6.5.3.8 Repeat 6.5.3.1 to 6.5.3.7 on a new test sample(s), after equilibration at $\left(35_{-2}^{\ 0}\right)$ °C.



Key

1 source of compressed gas
2 pressure controlling and measuring device
3 hose sample
4 loop having an inside diameter of approximately (300 ± 10) mm
5 suitable hose clamping arrangements (for preventing samples from rotating)
6 flow restrictor
7 flow meter

Figure 4 — Typical arrangement of coil kinking test showing different stages of straightening of hose when looped in clockwise direction



Key

1 source of compressed gas
2 pressure controlling and measuring device
3 hose sample
4 loop having an inside diameter of approximately (300 ± 10) mm
5 suitable clamping arrangements for securing hose sample. These shall prevent sample from rotating
6 flow restrictor
7 flow meter

Figure 5 — Typical arrangement of coil kinking test showing different stages of straightening of hose when looped in anti-clockwise direction *n*

6.5.4 Test report

The test report shall include information regarding those parameters specified in Clause 4, the pressure at which the test was conducted along with the initial flow rate, minimum flow rate and the percentage change in the gas flow rate, in both clockwise and anticlockwise directions, at both low and high temperature. Any deviations from the test method shall be reported.

6.6 Corner kinking for hoses greater than two metres and up to and including 10 m in length

6.6.1 Principle

When a hose is bent it can reduce the gas flow to the wearer of the RPD. The objective of this test is to quantify the reduction in the gas flow rate to the RPD when the hose is bent over a 90° corner.

6.6.2 Apparatus

6.6.2.1 Two hose samples, at least 1,0 m long.

6.6.2.2 Metal block, at least (250 ± 12) mm long and (250 ± 12) mm wide, with at least one corner radiused to 10 mm.

6.6.2.3 Hanger, with mass arrangement capable of imposing a force of (250 ± 13) N on the sample.

6.6.2.4 Oven and/or **environmental chamber**, capable of maintaining an air temperature of $\left(-5^{+2}_{0}\right)$ °C and $\left(35^{\ 0}_{-2}\right)$ °C, respectively.

6.6.2.5 Source of compressed gas, capable of flowing gas through the hose sample at a rate of (110 ± 5) l/min at the minimum pressure specified by the manufacturer.

6.6.2.6 Pressure controlling and measuring device(s).

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

6.6.2.8 Flowmeter, capable of measuring the gas flow rate to the nearest 3 l/min.

6.6.3 Procedure

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

6.6.3.2 Within 60 s of removing the hose sample from the environmental conditioning chamber or oven,

— 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 hose sample, and

— adjust the source of compressed gas and flow restrictor to attain an gas flow rate of (110 ± 5) l/min at the minimum pressure specified by the manufacturer.

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

6.6.3.3 Within an additional 30 s, bend the centre of the sample around a corner of the metal block having a radius of 10 mm, and attach the hanger assembly-progressively applying a force of (250 ± 13) N within 5 s to 8 s. See Figure 6.

6.6.3.4 Record the flow rate as Q_{t2}.

6.6.3.5 Calculate the percentage change in gas flow rate (Q%) as shown in Formula (3):

$$Q\% = \frac{Q_{t1} - Q_{t2}}{Q_{t1}} \times 100 \qquad (3)$$

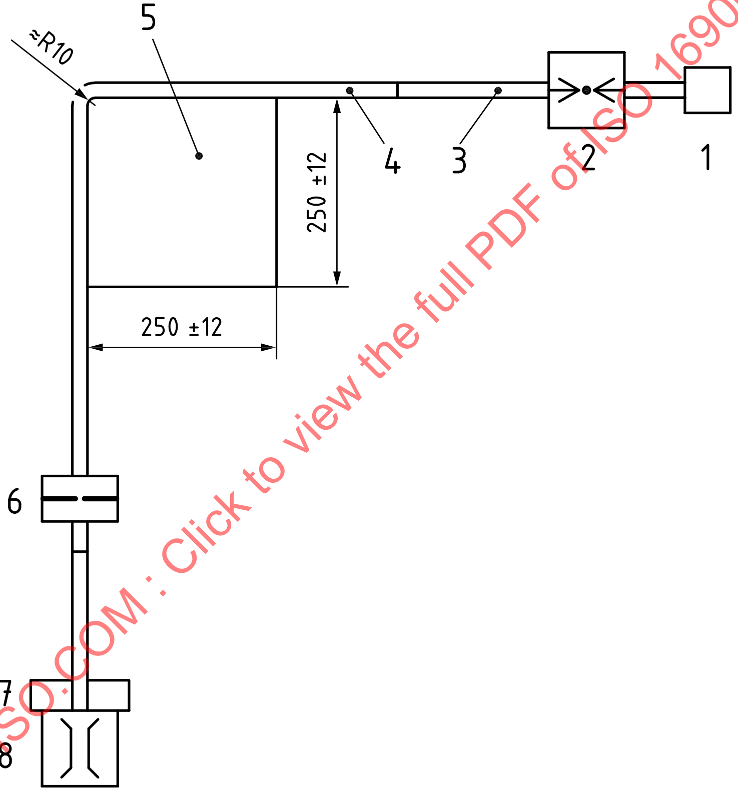
where

Q_{t1} is the gas flow rate before the bending of the hose;

Q_{t2} is the gas flow rate after bending of the sample and application of the force.

6.6.3.6 Repeat 6.6.3.1 to 6.6.3.5 on a new test sample(s), after equilibration of the sample(s) at $\left(35_{-2}^{\ 0}\right)$ °C.

Dimensions in millimetres



Key

1 source of compressed gas
2 pressure controlling and measuring device
3 straight connector
4 hose sample
5 metal block (radiused to 10 mm, on at least one edge)
6 flow restrictor
7 hanger assembly
8 flow meter

Figure 6 — Typical arrangement for determining the resistance of a hose to corner kinking

6.6.4 Test report

The test report shall include information regarding those parameters specified in Clause 4, the pressure at which the test was conducted along with the initial flow rate, minimum flow rate and the percentage change in the gas flow rate, at both low and high temperature. Any deviations from the test method shall be reported.

6.7 Exposure to impact from drop

6.7.1 Principle

RPD can be damaged after impact, particularly those which have a large mass. The objective of this test is to determine the ability of the specimen to withstand impact in its “ready for use state” when dropped three times from a height of 1,0 m, once in each axis (X, Y and Z axis).

6.7.2 Apparatus

6.7.2.1 Filters in their “ready for assembly state” and RPD in its “ready for use state” as specified by the manufacturer. Supplied breathable gas RPD including a compressed breathable gas cylinder can be tested at a reduced pressure as agreed between the manufacturer and the third party.

6.7.2.2 Steel plate, at least 600 mm long, 600 mm wide and 5 mm thick. The plate shall be sufficiently flat so that the level difference between any two points on the surface is no more than 2 mm. The plate shall rest, in full contact, on a flat level and smooth surface.

6.7.2.3 Release mechanism

The specimen shall be held in the required orientation in a light fabric mesh which is suspended by a single flammable thread, see Figures 7, 8 and 9. The specimen is released by the application of a heat source adjacent to the thread but not in contact with the thread so as not to influence its orientation. The mesh shall be sufficiently lightweight so as not to significantly influence the magnitude of the impact. In the case of irregularly shaped RPD the details of the impact orientation shall be agreed between the manufacturer and the test authority.

NOTE It is desirable to choose a mesh which is as light as possible but is capable of holding the specimen.

6.7.3 Procedure

6.7.3.1 Prepare the filter into its “ready for assembly state” or the RPD into its “ready for use state”. Determine the three axes of orientation (X, Y, Z) to be used in the tests.

In the case of a removable filter the flow axis (Z) is determined by the direction of the flow at the effluent/exit side of the filter.

In the case of irregularly shaped filters or RPD, the Z orientation shall be agreed upon between the manufacturer and the test authority.

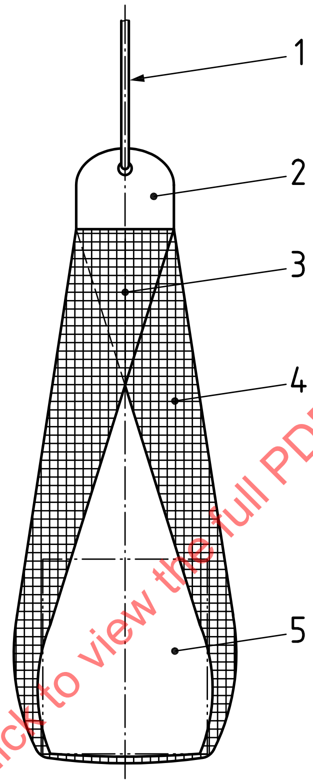
6.7.3.2 Place the specimen in the light fabric mesh bag and centre it above the steel plate with the lowest point of the specimen is at the $\left(1^{+0,1}_{\ \ 0}\right)$ m elevation mark. In the case of a filter the air flow axis is in the vertical position, with the connector facing upwards, (Z axis vertical). See Figure 8.

6.7.3.3 Once the specimen has stabilised, release it by applying heat to the retaining thread such that it parts without stretching.

6.7.3.4 Repeat 6.7.3.2 and 6.7.3.3 but with the X axis vertically downward followed by an impact test with the Y axis vertically downwards.

6.7.3.5 After impact, thoroughly examine the specimen, noting any damage or physical anomalies. The total period of time to complete 6.7.3.1 to 6.7.3.5 shall not exceed 10 min.

Immediately after the drop test, further testing with the specimens shall be performed. If immediate testing is not possible the specimens shall be sealed for storage and tested within 24 h of the drop.



Key

1 release thread

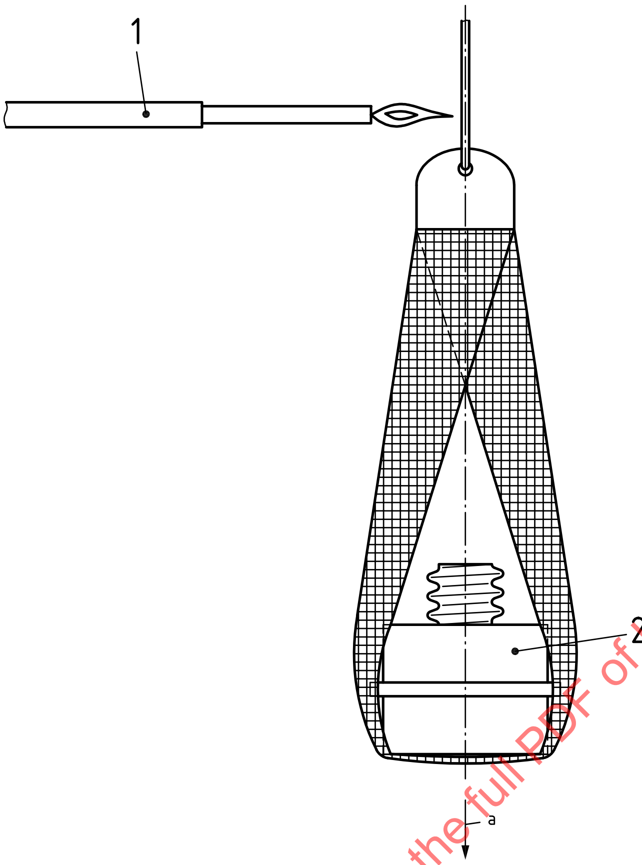
2 clamp

3 folded mesh area

4 mesh strip

5 space for placement of specimen

Figure 7 — Typical support arrangement for determining the resistance of specimens to drop impact



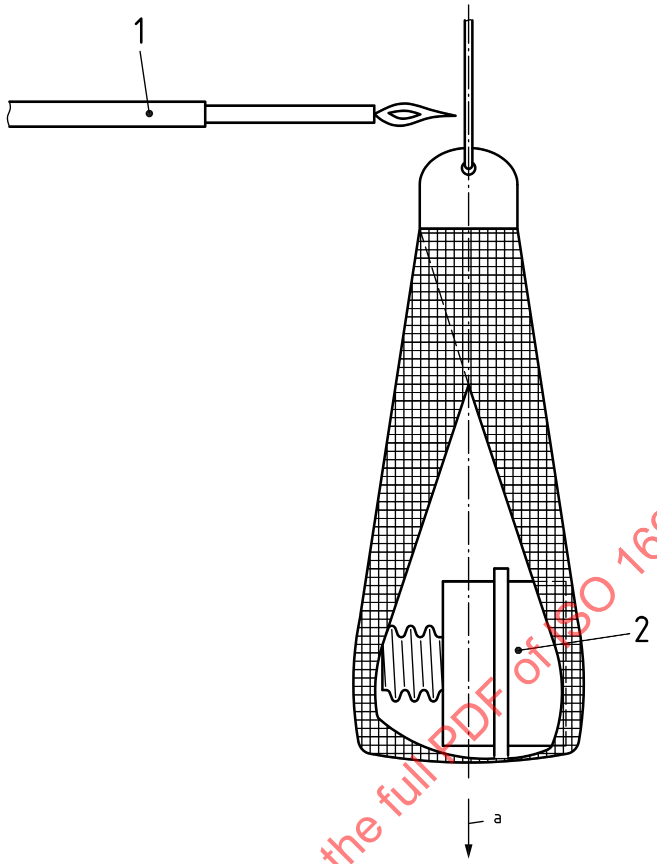
Key

1 release heat source

2 specimen

[a] Free fall direction.

Figure 8 — Typical support arrangement for a replaceable filter for resistance against drop: filter in vertical (Z) orientation



Key

1 release heat source

2 specimen

a Free fall direction.

Figure 9 — Typical support arrangement for a replaceable filter for resistance against drop: filter in X or Y orientation

6.7.4 Test report

The test report shall include information regarding those parameters specified in Clause 4 along with any visible or physical anomalies to the specimen. For irregularly shaped filters and RPD, include photographs of the drop arrangement/orientation.

6.8 Mechanical stress

6.8.1 Principle

Respiratory protective devices or components can be damaged after repeated mechanical stress, i.e. physical vibration. The objective of this test is to subject a RPD in its ready for use state or component in its ready for assembly state to a repeated mechanical stress.

NOTE This test method is specifically for filtering RPD and filters.

6.8.2 Sample and equipment

6.8.2.1 Filters in their “ready for assembly state” and Filtering RPD in its “ready for use state” as specified by the manufacturer.

Only one specimen shall be placed into each compartment of the conditioning equipment as shown in Figure 14.

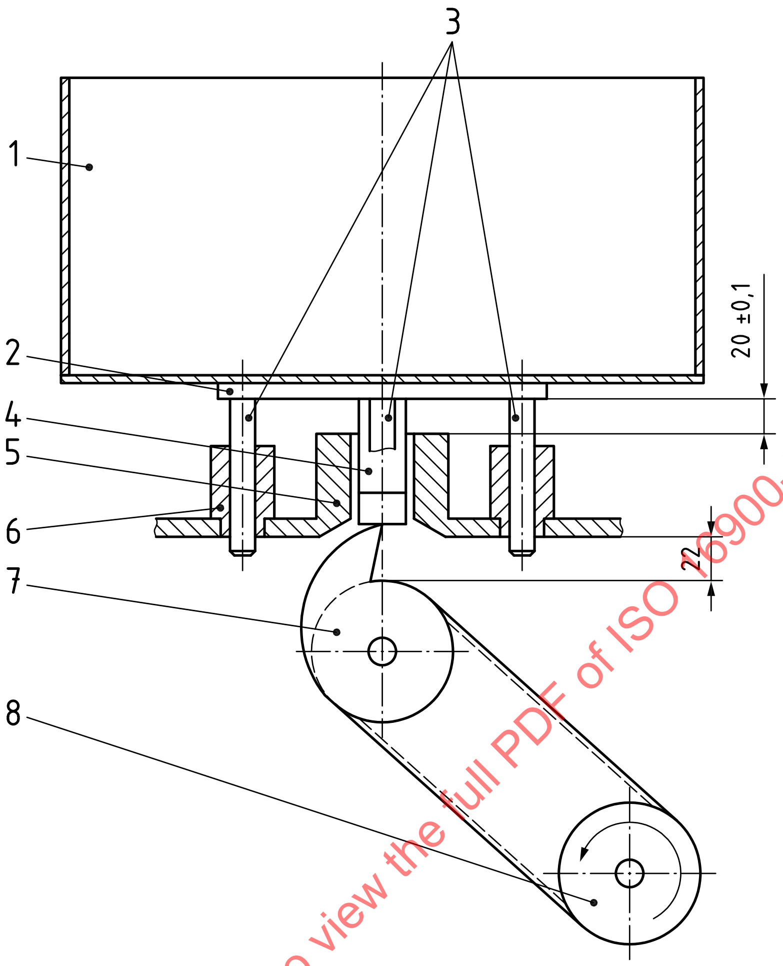
Specimens shall be positioned in the square steel case in their ready for assembly state or ready for use state as appropriate, allowing horizontal movement and free vertical movement within their compartments, see 6.8.3.

After the conditioning, any loose material that may have been released from the specimen shall be removed prior to any further testing.

6.8.2.2 Equipment

The mechanical stress test (MST) equipment as shown in Figure 10 consists of a square steel case (key item 1), containing the specimen(s) to be tested, which is able to drop repeatedly onto a rigid mass from a height of (20 ± 0,1) mm.

The rigid mass of the construction, onto which the steel case drops shall be at least 10 times the mass of the steel case. This may be achieved by bolting the base plate to a hard solid floor or by bolting the base plate to a rigid construction such as a concrete slab of the appropriate size and mass. The piston (item 4) and case shall be raised by a rotating cam (item 7) to a vertical height and allowed to fall under its own weight, guided by four vertical rods (item 3) each sliding through linear guides (item 6) onto a cylindrical centre plate (item 5). The cam rotates at a rate of (100 ± 5) r/min driven by a motor (item 8). The impact shall occur between the rod attachment plate (item 2) and the cylindrical centre plate (item 5).



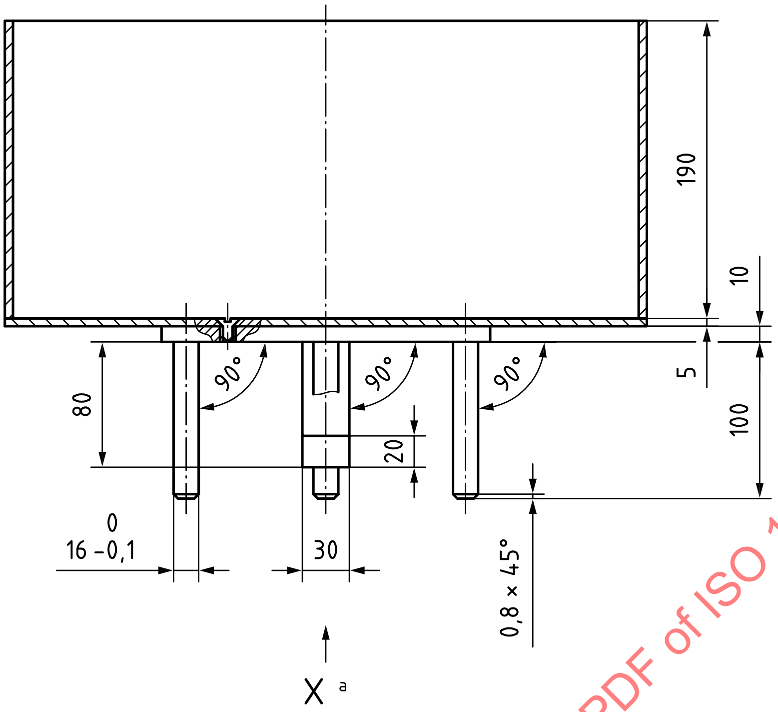
Key

1 square steel case
2 rod attachment plate
3 vertical rods
4 piston
5 cylindrical centre plate
6 linear guides
7 cam
8 motor drive

Figure 10 — Typical configuration of a MST-Equipment

The square steel case shall have a side of (400 ± 100) mm, a height of (200 ± 10) mm and a mass of (14 ± 1) kg, see Figure 11. The thickness of the bottom of the case shall be a minimum of 5 mm. The thickness of each of the sides shall all be identical and shall be selected to give the required mass.

Dimension in millimetres



a See Figure 12 for the view of the four linear guides.

Figure 11 — Typical square steel case and circular plate with attached vertical rods and piston

The rod attachment plate is bolted to the bottom of the steel case. The vertical piston is attached to the centre of the plate such that it faces the rotating cam, see Figure 10 and 11. Four vertical rods are also affixed to this plate by screws, symmetrically arranged parallel to the side walls, centred on a diameter of (225 ± 1) mm. The rods shall be well lubricated in order to avoid friction between the rods and the guides. Details of the rods and guides are shown in Figures 11 and 12.

Dimensions in millimetres

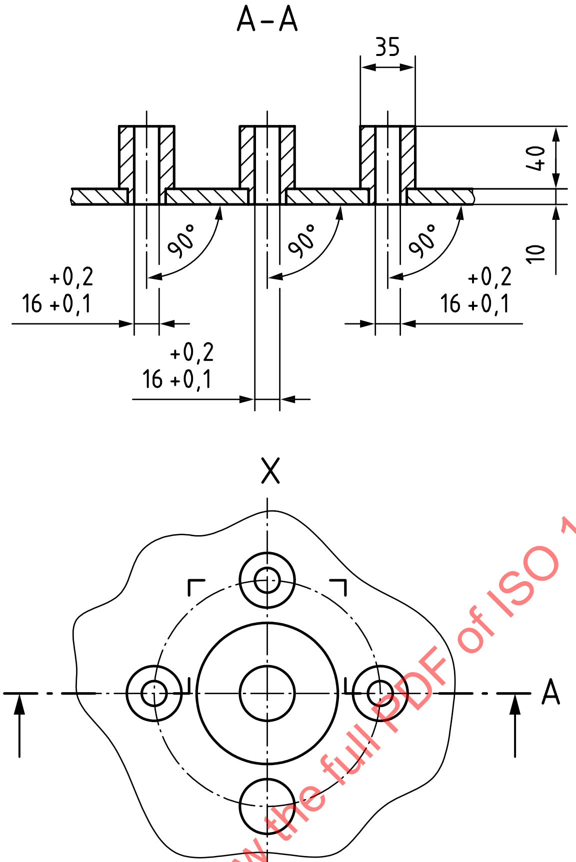


Figure 12 — Typical arrangement of the four linear guides (only 3 are shown)

Figure 13 shows a picture of a typical square steel case with the rod attachment plate to which the vertical piston is affixed.

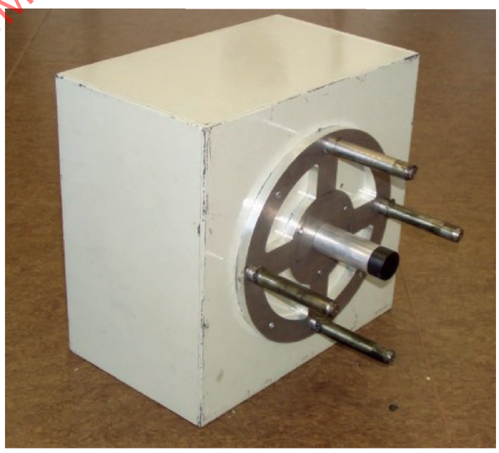


Figure 13 — Typical arrangement of a square steel case with four vertical rods and the piston in the centre of the rod attachment plate

The square steel case is equipped with light movable, perpendicular spacers, comb shaped, which can be combined to limit the lateral movement of the specimen to be tested, see Figure 14.

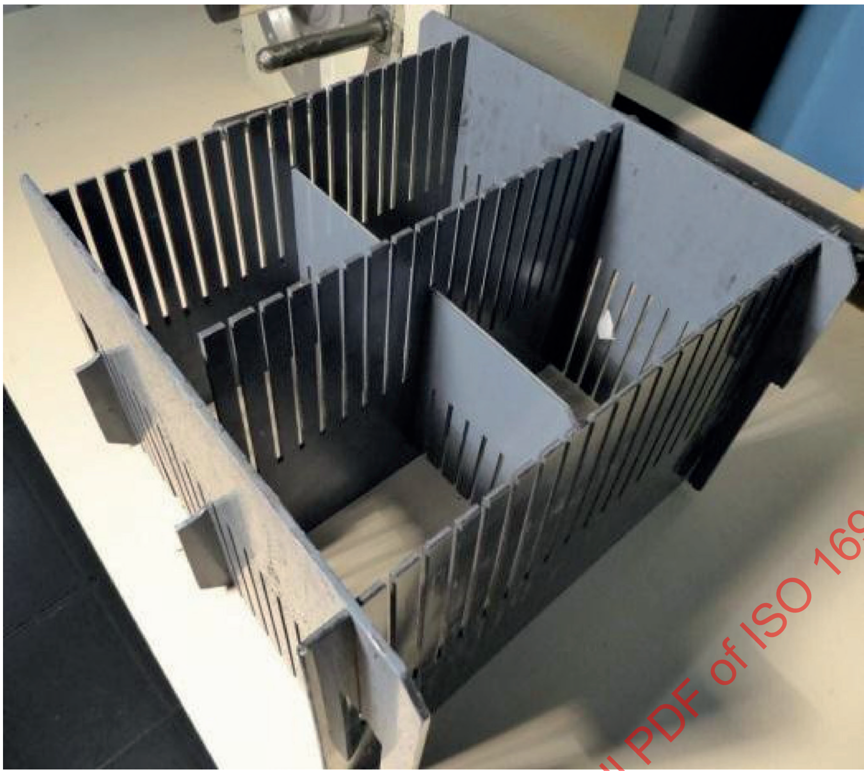


Figure 14 — Typical arrangement of spacers to create compartments inside the steel case

6.8.3 Procedure

Specimens shall be positioned in the square steel case allowing horizontal movement and free vertical movement within their compartments.

Only one specimen shall be placed into each compartment of the steel case as shown in Figure 14.

The compartment size shall be adjusted using the spacers to allow a horizontal movement of $(6^{+1}_{\ 0})$ mm in both the X and Y axes.

The specimen (one or more) shall be positioned to the extent possible in central area of the steel case. More than one specimen can be tested at the same time if they fit inside the spacers of the steel case, but they should be positioned, to the extent possible, symmetrically in respect to the central axis of the steel case. (e.g. if four specimens are to be tested, they shall be positioned in each of the four corners of the central area).

Specimens shall be mechanically conditioned for the number of cycles given in the relevant performance standard. In case of replaceable filters, the axis of air flow through the specimens shall be horizontal. Where specimens are to be cycled in all three axes, the number of cycles per axis shall be as stated in the performance standards. In the case of irregularly shaped RPD, the details of the orientations of the three axes shall be agreed between manufacturer and the test authority.

In case of replaceable filters, the axis of air flow through the specimens shall be horizontal and they shall be mechanically conditioned for 1 950 cycles.

For all other specimens, they shall be mechanically conditioned in all three axes for 650 cycles per axis. In the case of irregularly shaped RPD the details of the orientations of the three axes shall be agreed between the manufacturer and the test authority.

After the conditioning, any loose material that may have been released from the specimen shall be removed prior to any further testing.

6.8.4 Test report

The test report shall include information regarding those parameters specified in Clause 4 along with any visible or physical anomalies to the RPD.

6.9 Strength of visor

6.9.1 Principle

Visors of respiratory protective devices can be damaged by an impact, thereby altering the function and fit of the RPD. The objective of this test is to evaluate the ability of a visor, when properly installed in a RPD, to withstand impact by a projectile (steel ball).

6.9.2 Apparatus

6.9.2.1 Respiratory interface, equipped with a visor.

6.9.2.2 Oven and/or **environmental chamber**, capable of maintaining an air temperature of $\left(-5^{+2}_{0}\right)$ °C and $\left(35^{0}_{-2}\right)$ °C, respectively.

6.9.2.3 Respiratory protective device headform as specified in ISO 16900-5, the appropriate size for the respiratory interface plus RPD torso, where necessary, on which the RPD with components can be properly mounted;

6.9.2.4 Steel ball, (22 ± 1) mm in diameter and (44 ± 2) g in mass.

6.9.2.5 Quick release mechanism, capable of holding the steel ball, and permits its unobstructed drop on to the specimen.

6.9.3 Procedure

6.9.3.1 Equilibrate the specimen for 1 h minimum, at $\left(-5^{+2}_{0}\right)$ °C.

6.9.3.2 Within 60 s of removing the specimen from the temperature conditioning chamber

— securely mount it to the appropriate headform or headform-torso assembly, if appropriate,

— position the headform such that the impact of the steel ball to the visor is perpendicular, and

— impact the visor with the steel ball from a height of $\left(130^{+5}_{0}\right)$ cm.

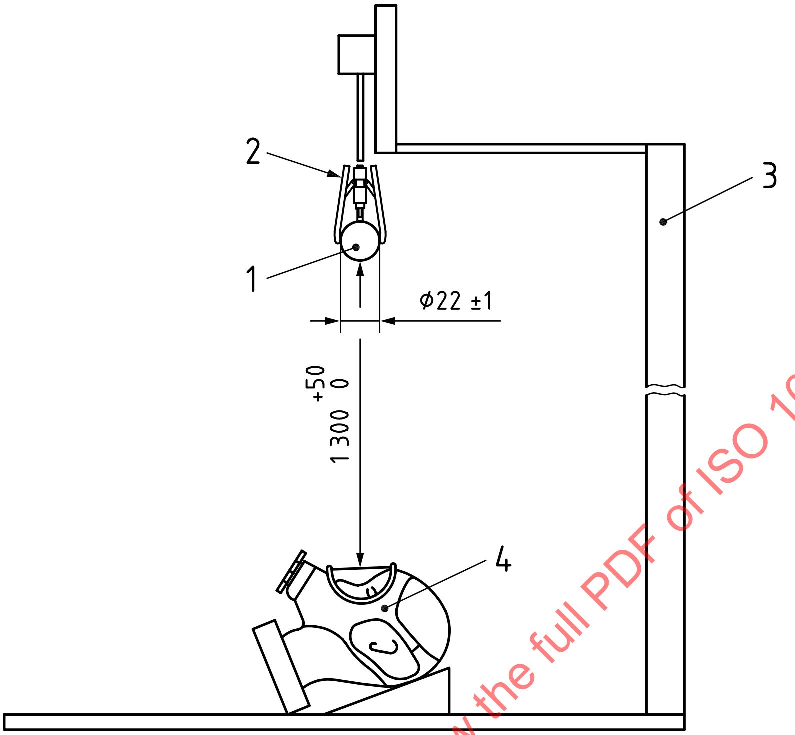
Alternatively, the specimen may be securely mounted to the headform, and both subsequently equilibrated in an environmental chamber.

A typical arrangement is shown in Figure 15.

6.9.3.3 Repeat 6.9.3.1 and 6.9.3.2 on the same specimen, mounted on a headform, but conditioned at $\left(35^{0}_{-2}\right)$ °C. After equilibration at $\left(35^{0}_{-2}\right)$ °C, the steel ball shall not impact the visor within 30 mm of the location used in the previous test. If the respiratory interface is equipped with a binocular viewing system, use one lens for impacting after equilibration at $\left(35^{0}_{-2}\right)$ °C, and use the other lens for impacting after equilibrating at $\left(-5^{+2}_{0}\right)$ °C.

6.9.3.4 After impact, thoroughly examine the respiratory interface with visor, noting any separation of material from the inner surface, as well as damage or physical anomalies which can alter its fit or function.

Dimensions in millimetres



Key

1 steel ball

2 quick release mechanism

3 supporting stand,

4 RPD headform of appropriate size with mounted specimen rigidly supported on the base

Figure 15 — Typical arrangement for determining the resistance to impact of a visor

6.9.4 Test report

The test report shall include information regarding those parameters specified in Clause 4 along with any damage or anomalies to the respiratory interface with visor which can present a hazard to the wearer.

6.10 Strength of connections

6.10.1 Principle

The objective of this test method is to determine if the following meet the minimum specified axial force requirements:

— the connections of filters or of supplied breathable gas devices to a respiratory interface;

— components attached to the respiratory interface having the potential of being hooked or snagged;

— breathable gas supply connections not directly attached to the respiratory interface;

NOTE This includes any connection within the breathable gas supply chain, e.g. T-pieces, elbow connections and connections between hoses.

— high-pressure hose connections.

6.10.2 Sample and equipment

6.10.2.1 Complete RPD, to be tested.

6.10.2.2 RPD headform as specified in 16900-5, of the size appropriate to the respiratory interface, plus RPD torso, where necessary, on which the RPD with components can be properly mounted;

6.10.2.3 F_x, **force probe** as specified in 16900-5, with 5 mm index ball.

6.10.2.4 Suitable means of imposing the axial force(s), to the components to be tested.

6.10.3 Procedure for evaluating the strength of connections to a respiratory interface

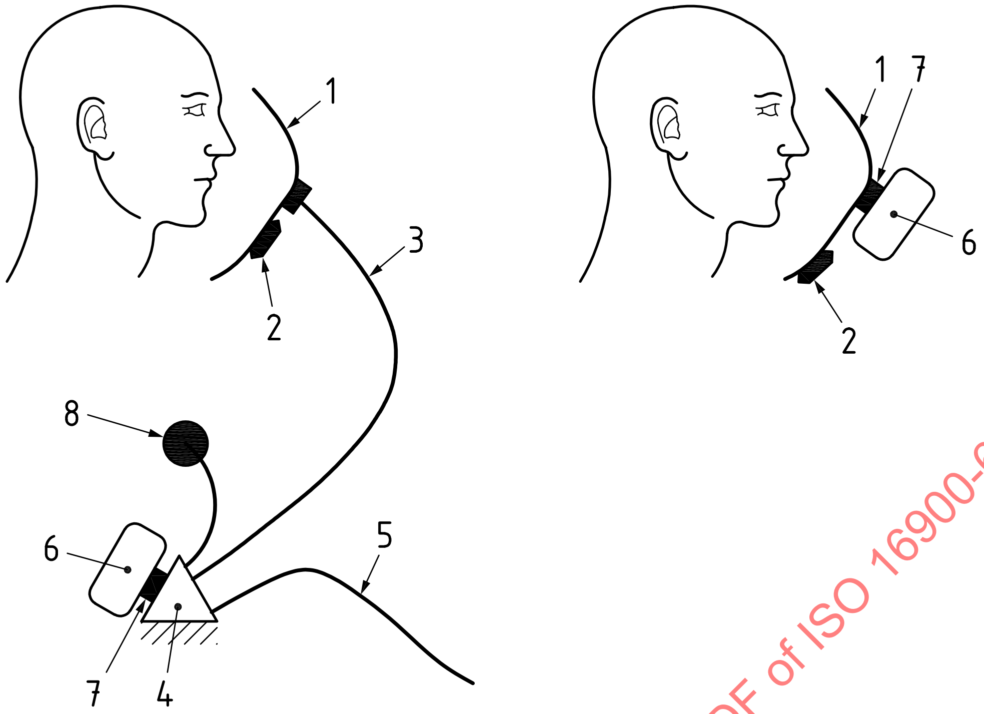
6.10.3.1 Securely attach the headform (and torso, if necessary) to a solid surface.

6.10.3.2 Securely mount the respiratory interface with components to the headform (and torso, if necessary).

6.10.3.3 Use the F_x force probe to determine which of the respiratory interface components have the potential to be caught or snagged during use. The F_x force probe is used as follows:

The surface of the respiratory interface (or other components of the RPD) shall be probed with the ball of the F_x force probe to identify any openings or gaps that are large enough to allow the ball to enter, therefore giving the potential for the component to be caught or snagged. If the ball can enter the opening or gap, then the component shall be tested with an axial force.

Examples of such connections and components are shown in Figure 16.



Key

1 respiratory interface
2 accessory/exhalation valve
3 low or medium pressure hose
4 manifold attached to torso
5 medium pressure hose (from supply source)
6 filter
7 filter connection
8 pressure gauge/warning device/quick fill

Figure 16 — Illustration of typical components and connections to be evaluated for both filtering and supplied breathable gas RPD

6.10.3.4 Position the headform (and torso, if necessary) with the specimen such that an axial pull force can be imposed on the connections of filters or of supplied breathable gas devices to a respiratory interface, as well as those components identified as having the potential of being "caught or snagged." Examples of the components and connections are shown (schematically) in Figure 16. The direction of the applied forces is shown in Figure 17.

NOTE By positioning the respiratory interface onto the headform the strength of the attachment of the respiratory interface to the head form is included in this test.

If it is not possible to apply the required force for the required time due to breakage or loosening of the attachment (e.g., by slippage of a belt through buckles), this is deemed to be a failure. Dislodging of the respiratory interface from the head form is not deemed to be a failure and shall not stop testing.

