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Respiratory protective devices — Methods of test and test equipment —

Part 1: Determination of inward leakage

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

Partie 1: Détermination de la fuite vers l'intérieur

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Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 16900-1 was prepared by Technical Committee 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*

Introduction

This draft international standard is intended as a supplement to the specific device standards for respiratory protective devices. Test methods are specified for complete or parts of devices. If deviations from the test method given in this standard are necessary, these deviations will be specified in the relevant device standard.

Respiratory protective devices — Methods of test and test equipment —

Part 1: Determination of inward leakage

1 Scope

This international Standard specifies laboratory test methods for determining inward leakage (IL) of complete respiratory protective devices and respiratory interfaces using specified test agents and incorporating specified body movements, at specified metabolic work rates. The results may differ from those achieved in actual use.

2 Normative references

The following referenced documents are indispensable for the application 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 16972, *Respiratory protective devices — Terms and Definitions and units of measurements*

ISO/TS 21748, *Guidance for the use of repeatability, reproducibility and trueness estimates in measurement uncertainty estimation*

3 Terms and definitions

For the purposes of this international Standard, the terms and definitions given in ISO 16972 apply, together with the following:

3.1
Inward leakage (IL)
Inward leakage of the ambient atmosphere into the mouth area of a respiratory interface from all sources, when measured in the laboratory in the specific atmosphere.

$$\text{Inward leakage (\%)} = \frac{(\text{concentration of challenge agent inside the respiratory interface})}{(\text{concentration of challenge agent outside the respiratory interface})} \times 100$$

3.2
Porous device
RPD incorporating materials (excluding any filters) that are porous to, or may be penetrated by gases and vapours under specified test conditions.

4 Prerequisites

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

— Number of test specimens;

— Test exercise schedule to be used (selected from the normative Annex C);

— Operating conditions of the RPD;

— Any prior conditioning or testing and sequence of preconditioning;

— Characteristics to be assessed subjectively (if appropriate), for example field of vision when assessed during the practical performance test.

5 General test requirements

Unless otherwise specified, the values stated in this international Standard 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 temperature 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.

6 Principle

A test subject wearing the device being tested, walks on a treadmill performing exercises at specified metabolic rates and surrounded by an atmosphere containing a known concentration of a test substance. During these exercises the concentration of the test substance inside and outside the respiratory interface is measured and compared.

Three challenge agents are specified, one solid aerosol, one liquid aerosol and a gas. The general principle of the test is the same for all substances. The substance used depends on the type of equipment being tested and is chosen according to Table 1.

7 Test Panel

7.1 General

Before performing tests involving respiratory test panels, account should be taken of any national or other regulations concerning, for example the medical history, examination or supervision of the test subjects.

Test subjects shall be trained in wearing the type of RPD being tested.

— Unless the RPD manufacturer's user instructions specify that the device can be worn by persons with facial hair, then male panel members shall be clean shaven in the area of the face seal.

— Persons with scars or other facial blemishes in the area of the face seal that might give rise to face seal leakage shall not be selected for the test panel.

— Persons shall follow the manufacturer's donning instructions, which may include a wearer seal check, to ensure an adequate fit. If a person cannot achieve an adequate fit following the manufacturer's instructions the person shall not be used for the inward leakage test.

— Where a manufacturer specifies a head or face size range for the device, only subjects who fall within the specified range shall be used for the test.

— If more than one size of respiratory interface is manufactured, the test subjects shall select the most appropriate size in accordance with the information supplied by the manufacturer.

7.2 Selection of test subjects

The selection and size of the respiratory test panel shall be as defined in ISO/TS 16976-2 clause 7.

8 Test agents

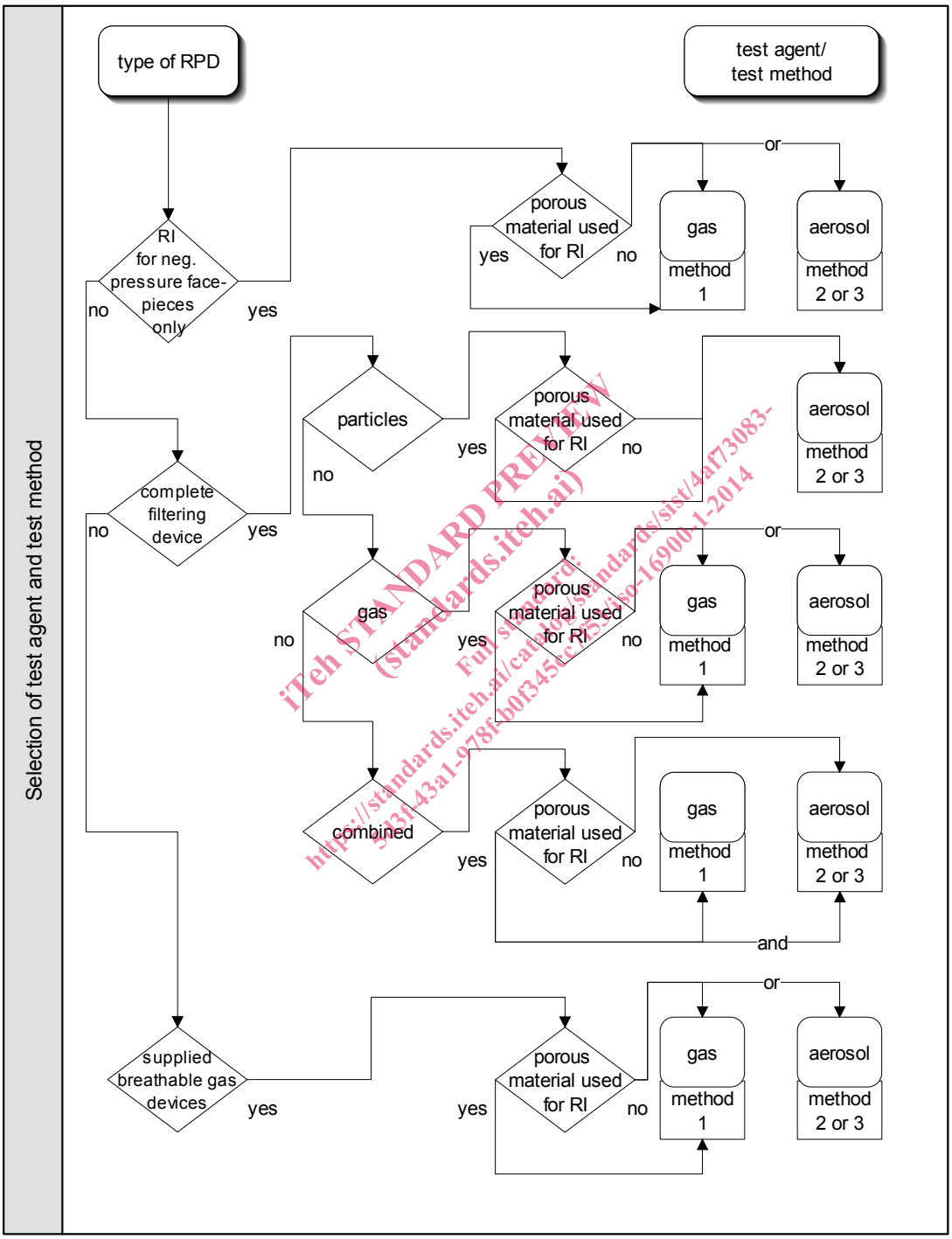
Three test agents are specified for the inward leakage tests:

1. Sulfur hexafluoride gas (SF_6)
2. Sodium chloride aerosol (NaCl);
3. Corn oil aerosol.

All three methods are equally acceptable for determination of inward leakage, subject to the requirements of Table 1.

Annex B describes a method for the determination of porosity.

Table 1 — Selection of test agent and method



9 Apparatus

9.1 Enclosure

The enclosure shall be large enough to permit the test subject to complete the test exercise schedule without restriction. A uniform and continuous flow of the relevant test atmosphere shall be delivered into the test chamber.

The concentration of the test atmosphere inside the effective working volume is to be checked to ensure it is sufficiently homogeneous (within ±10 %) and stable throughout the duration of the test.

The air velocity through the enclosure measured close to the test subject's head with the test subject standing centrally (on the treadmill where appropriate) and without the supplementary fans in operation, shall be sufficient to maintain the specified concentration but shall not exceed 0,2 m/s.

The enclosure shall be designed so that the test subject is visible from the outside of the enclosure at all times whilst in the enclosure. A means of providing communication between the test subject(s) and the test supervisor(s) shall be provided.

For devices which are required additionally to be tested under crosswind conditions, provision shall be made for the positioning of supplementary fans, not less than 350 mm in diameter, in the front, at the side (left or right) and at the rear of the test subject and located inside the enclosure such that an air velocity of 2 m/s across the enclosure can be produced in the vicinity of the test subject's head.

The design of the enclosure shall be such that the device worn by the subject can be supplied with clean air (free of the test agent) if necessary.

The volume of the test chamber shall be large enough, and the replacement of the test atmosphere, shall be such as to prevent dilution of the test atmosphere by clean air emanating from the device under test.

NOTE When SF_6 gas is employed as the test atmosphere the test chamber should preferably permit re-circulation of the air/SF_6 volume to minimise exhaust of SF6 into the ambient atmosphere.

9.2 Treadmill

Where a treadmill is specified, a treadmill capable of working up to the speed as required by the exercise schedule.

9.3 Test agent generator – general

The test agent generator shall be capable of generating the test agent in the required concentration, and, in case of an aerosol, of the required particle size distribution.

9.4 Detection system – general

The detection system including sampling probes and connections shall have a response time of less than 20 s for a response of 10 % to 90 % of the full-scale deflection of the range used.

If only one detector is used check that the readings from the two sample lines (the enclosure and the respiratory interface) are within 2 % of each other and if necessary adjust the sampling characteristics of the lines. Care shall be taken to ensure that at the sampling point for measuring the chamber concentration, the concentration of the test agent is stable in time and that the measurement of the concentration will not have an adverse effect on the detector reading for the lower concentration measurement.