INTERNATIONAL STANDARD

ISO 17491-1

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Protective clothing — Test methods for clothing providing protection against chemicals —

Part 1: Determination of resistance to outward leakage of gases (internal pressure test)

Vêtements de protection — Méthodes d'essai pour les vêtements fournissant une protection contre les produits chimiques —

Partie 1: Détermination de la résistance aux fuites des gaz vers l'extérieur (essai de pression interne)

Reference number
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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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.

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.

ISO 17491-1 was prepared by Technical Committee ISO/TC 94, *Personal safety — Protective clothing and equipment*, Subcommittee SC 13, *Protective clothing*.

This edition of ISO 17491-1, together with ISO 17491-2, ISO 17491-3, ISO 17491-4 and ISO 17491-5, cancels and replaces ISO 17491:2002 which has been technically revised.

ISO 17491 consists of the following parts, under the general title *Protective clothing — Test methods for clothing providing protection against chemicals*:

— *Part 1: Determination of resistance to outward leakage of gases (internal pressure test)*

— *Part 2: Determination of resistance to inward leakage of aerosols and gases (inward leakage test)*

— *Part 3: Determination of resistance to penetration by a jet of liquid (jet test)*

— *Part 4: Determination of resistance to penetration by a spray of liquid (spray test)*

— *Part 5: Determination of resistance to penetration by a spray of liquid (manikin spray test)*

Introduction

Chemical protective clothing is worn in conjunction with appropriate respiratory protective devices in order to isolate the body of the wearer from the environment. Several tests exist for determining the resistance of chemical protective clothing materials to either the permeation or penetration of gaseous or liquid chemicals.

However, the effectiveness of the overall protective clothing item in preventing exposure to chemical hazards depends on the integrity of the clothing item's design in eliminating or reducing inward leakage of chemicals.

The selection of the appropriate integrity test method will depend on the application of the chemical protective clothing and the exposure hazards present. Usually, the integrity test method will be specified in the overall chemical protective clothing specification.

Evaluations of the chemical resistance of protective clothing material should be carried out using the appropriate test.

ISO 6529 specifies methods for measuring the resistance of protective clothing materials to permeation by either liquids or gases. ISO 13994 specifies a method for determining the penetration resistance of protective clothing materials under conditions of continuous liquid contact and pressure, and can be applied to micro-porous materials, seams and assemblages. ISO 6530 specifies a procedure for measuring the penetration resistance of protective clothing materials from the impact and runoff of liquids. General protective clothing requirements are specified in ISO 13688.

This International Standard specifies six different test methods for determining the resistance of complete protective clothing to inward leakage of either gaseous or liquid chemicals (protective clothing integrity). These test methods apply to either liquid or gaseous chemicals, or aerosols, and vary in the level of severity.

The integrity test methods specified by this International Standard are as follows.

This part of ISO 17491 specifies a method to be performed either at minimum test settings (Method 1) or at more rigorous test settings (Method 2), for assessing the resistance of a gas-tight suit to outward leakage of air through, for example, essential openings, fastenings, seams, interface areas between items, pores and any imperfections in the construction materials.

ISO 17491-2 specifies two different methods for determining the inward leakage of chemical protective suits in an aerosol environment (Method 1) or a gaseous environment (Method 2). The procedure is applicable to gas-tight suits and non-gas-tight suits and provides an evaluation of chemical protective suit integrity, particularly with regard to leakage in the breathing zone, under dynamic conditions through the use of human subjects.

ISO 17491-3 specifies a method for determining the resistance of chemical protective clothing to penetration by jets of liquid chemicals. This procedure is applicable to clothing worn in situations where there is a risk of exposure to a forceful projection of a liquid chemical and which is intended to be resistant to penetration under conditions that require total body surface cover (but not gas-tight clothing).

ISO 17491-4 specifies a method to be performed either at minimum test settings (Method A — low-level spray test) or at more rigorous test settings (Method B — high-level spray test) for determining the resistance of chemical protective clothing to penetration by sprays of liquid chemicals. This procedure applies to protective clothing which is intended to be worn when there is a risk of exposure to slight splashes of a liquid chemical or to spray particles that coalesce and run off the surface of the garment, and to clothing which is intended to be resistant to penetration under conditions that require total body surface cover (but not gas-tight clothing).

ISO 17491-5 specifies an alternative test method for determining the resistance to spray penetration. It uses a static manikin instead of a test subject; it also uses a different spray configuration and duration.

The methods specified in this part of ISO 17491, ISO 17491-2, ISO 17491-3, ISO 17491-4 and ISO 17491-5 are not appropriate for evaluating the permeation or penetration of liquid chemicals through the material from which the clothing is made.

Protective clothing — Test methods for clothing providing protection against chemicals —

Part 1: Determination of resistance to outward leakage of gases (internal pressure test)

1 Scope

This part of ISO 17491 specifies a method to be performed either at minimum test settings (Method 1) or at more rigorous test settings (Method 2), for assessing the resistance of a gas-tight suit to outward leakage of air through, for example, essential openings, fastenings, seams, interface areas between items, pores and any imperfections in the construction materials.

This test does not simulate penetration by gases in an inward direction. Although the danger to the wearer arises from leakage in an inward direction, this test method assesses the outward leakage of air after the gas-tight suit has been inflated so as to stretch the construction material, thereby enabling the test method to detect very small imperfections, such as holes, splits or tears.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
assemblage
permanent fastening between two or more different garments, or between chemical protective clothing and accessories, obtained, for example, by sewing, welding, vulcanizing or gluing

2.2
chemical protective clothing
combined assembly of garments worn to provide protection against exposure to, or contact with, chemicals

2.3
chemical protective suit
clothing worn to protect against chemicals that covers the entire, or most of, the body

NOTE 1 A chemical protective suit may comprise garments combined together to protect the body.

NOTE 2 A suit may have various types of additional protection joined to it, such as a hood or helmet, boots and gloves.

2.4
connection
assemblage or joint

2.5
garment
individual component (of chemical protective clothing), the wearing of which provides protection against contact with chemicals to the part of the body that it covers

2.6
gas-tight suit
one-piece garment with hood, gloves and boots which, when worn with self-contained or air-line breathing apparatus, provides the wearer with a high degree of protection against harmful liquids, particles and gaseous or vapour contaminants

2.7
joint
non-permanent fastening between two different garments, or between chemical protective clothing and accessories

2.8
non-gas-tight suit
one-piece garment with hood, glove and boots which, when worn with or incorporating self-contained or air-line breathing apparatus, provides the wearer with a high degree of protection against harmful liquids, particles and gaseous or vapour contaminations but does not meet an outward gas leakage test (internal pressure test)

2.9
penetration
flow of a chemical through closures, porous materials, seams, holes or other imperfections in a protective clothing material, on a non-molecular level

2.10
permeation
process by which a chemical moves through a protective clothing material on a molecular level

NOTE Permeation involves

a) sorption of molecules of the chemical into the contacted (outside) surface of a material,

b) diffusion of the sorbed molecules in the material, and

c) desorption of the molecules from the opposite (inside) surface of the material.

2.11
protective clothing material
any material or combination of materials used in an item of clothing for the purpose of isolating parts of the body from a potential hazard

3 Principle

After the suit has been inflated to a defined pressure, the extent of the subsequent leakage of air is assessed by recording the pressure reached after a defined period. Two different sets of test pressures are provided.

Method 1 uses an inflation pressure of 1 250 Pa and a test pressure of 1 000 Pa.

Method 2 uses an inflation pressure of 1 750 Pa and a test pressure of 1 650 Pa.

Method 1 is considered the minimum internal pressure test, but Method 2 provides a more rigorous determination of suit gas-tight integrity.

4 Apparatus

4.1 Source of compressed air, supplying air within the temperature range of (20 ± 5) °C.

4.2 Pressure-measuring device, capable of measuring up to (1 750 ± 50) Pa with a sensitivity (readability) of 50 Pa.

4.3 Vent valve-closure components, such as plugs or other means that are to be supplied for test purposes by the manufacturer.

4.4 Stop clock or **appropriate timing device**, capable of measuring to the nearest second.

5 Procedure

5.1 General

a) Lay out the chemical protective suit (including attached gloves and footwear and full facemask, if appropriate) on a suitable flat and clean surface away from any sources of heat and/or currents of air.

b) Select an area for testing that is away from direct sunlight, open doors, drafts, heating and air conditioning registers.

c) Perform a visual inspection of the chemical protective suit. Check the chemical protective suit for seam integrity by visually examining the seams and gently pulling on the seams. Ensure that all air supply lines, fittings, the visor or face shield, zippers and valves are secure and show no signs of deterioration.

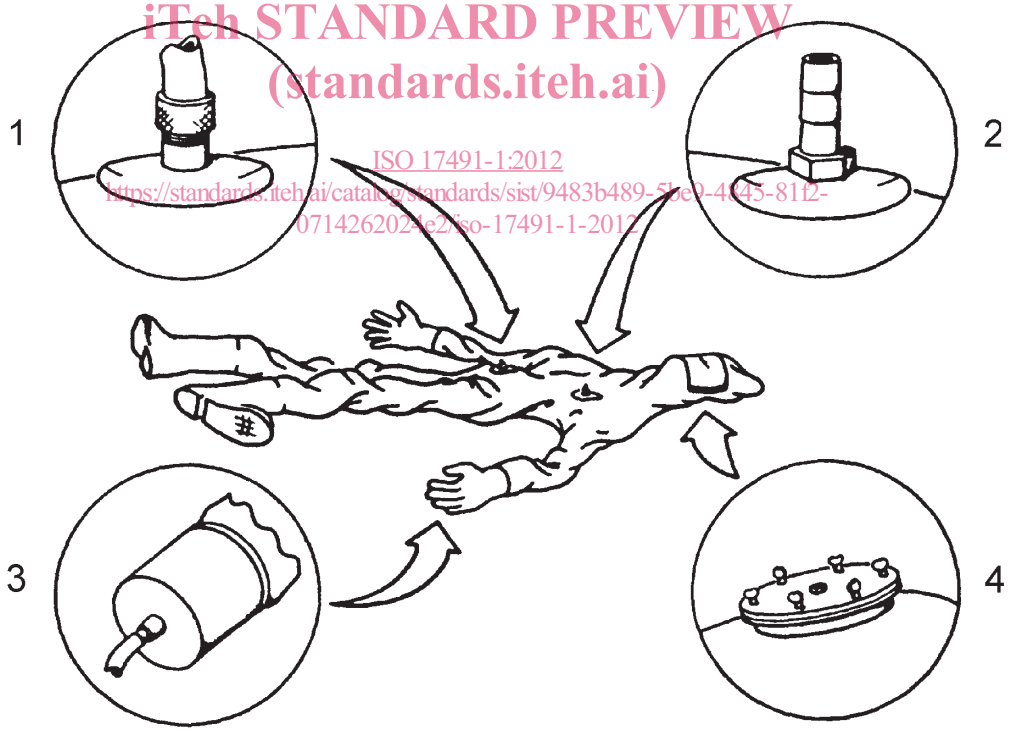
d) Remove any creases and folds in the suit as far as practicable.

e) Leave the suit for a minimum of 1 h at ambient temperature ± 3 °C.

f) Inflate using the connections illustrated in Figure 1. Attach the pressure-measuring device (4.2) to the chemical protective suit or inflation system.

g) Carefully blank off the valves and other openings on the chemical protective suit with appropriate means of closure supplied by the manufacturer.

h) Choose either Method 1 or Method 2.



Key

1 airline connector or inflation couple
2 suit venting-valve adapter
3 removable gloves
4 face-plate seal

Figure 1 — Typical examples of suit modification to permit inflation

5.2 Method 1 — Minimum procedure

a) Using compressed air (4.1) inflate the suit carefully to a pressure of (1 250 ± 50) Pa.

b) Maintain the pressure at (1 250 ± 50) Pa for at least 1 min by adding air, if necessary, while ensuring that any creased areas are unfolded and that the suit is stretched as appropriate.

NOTE During this period, the temperature is stabilized and the pressure throughout the suit reaches equilibrium.

c) After a period of at least 1 min has elapsed [see 5.2 a)], adjust the pressure in the suit to the test pressure of (1 000 ± 50) Pa.

d) Allow a further 4 min to elapse. Note and record the final pressure in the suit in pascals. Pay careful attention to the cleanliness and refitting of valves that have been obstructed or removed to carry out the test, to ensure that they function satisfactorily after the test.

e) If the chemical protective suit shows a 20 % or more drop in pressure [(test pressure minus the ending pressure/test pressure) × 100], check for leaks by inflating the suit to (1 250 ± 50) Pa and by brushing or wiping the entire chemical protective suit (including seams, closures, lens gaskets, glove-to-sleeve joints, etc.) with a mild soap and water solution.

Observe the wiped areas of the chemical protective suit for the formation of soap bubbles, which are an indication of a leak. Any commercially available high-sudsing soap solution has been found to offer satisfactory performance for this purpose.

NOTE In cases where the test is used for quality control or maintenance purposes, repair all identified leaks in accordance with specific manufacturer instructions, if permitted. Retest the repaired chemical protective suit as specified in 5.1 a) to 5.1 h) and 5.2 a) to 5.2 d).

5.3 Method 2 — Rigorous procedure

a) Using compressed air, inflate the suit carefully to a pressure of (1 750 ± 50) Pa.

b) Maintain the pressure at (1 750 ± 50) Pa for 10 min by adding air, if necessary, while ensuring that any creased areas are unfolded and that the suit is stretched as appropriate.

NOTE During this period, the temperature is stabilized and the pressure throughout the suit reaches equilibrium.

c) After the period of 10 min has elapsed [see 5.3 b)], adjust the pressure in the suit to (1 650 ± 50) Pa.

d) Allow a further 6 min to elapse. Note and record the final pressure in the suit in pascals. Pay careful attention to the cleanliness and refitting of valves that have been obstructed or removed to carry out the test, to ensure that they function satisfactorily after the test.

e) If the chemical protective suit shows a 20 % or more drop in pressure [(test pressure minus the ending pressure/test pressure) × 100], check for leaks by inflating the suit to (1 750 ± 50) Pa and by brushing or wiping the entire chemical protective suit (including seams, closures, lens gaskets, glove-to-sleeve joints, etc.) with a mild soap and water solution.

Observe the wiped areas of the chemical protective suit for the formation of soap bubbles, which are an indication of a leak. Any commercially available high-sudsing soap solution has been found to offer satisfactory performance for this purpose.

NOTE In cases where the test is used for quality control or maintenance purposes, repair all identified leaks in accordance with specific manufacturer instructions, if permitted. Retest the repaired chemical protective suit as specified in 5.1 a) to 5.1 h) and 5.3 a) to 5.3 d).

6 Test report

The test report shall include the following information:

a) a reference to this International Standard, i.e. ISO 17491-1:2012;

b) the method used, i.e. Method 1 or Method 2;

c) the manufacturer or supplier and any identifying mark;

d) the pressure recorded in 5.2 d) or 5.3 d) and the test temperature;

e) any further qualifying remarks and observations;

f) the results of any retesting, after repair of the suit.