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**Protective clothing —
Protection against chemicals
—Determination of resistance of
protective clothing materials to
permeation by liquids and gases**

ICS 13.340.10

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Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of Health, Labour and Welfare and the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal of establishing a Japanese Industrial Standard from Japan Safety Appliances Association (JSAA)/Japanese Standards Association (JSA), with a draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law.

This Standard has been made based on **ISO 6529:2001** *Protective clothing—Protection against chemicals—Determination of resistance of protective clothing materials to permeation by liquids and gases* for the purpose of making it easier to compare this Standard with International Standard; to prepare Japanese Industrial Standard conforming with International Standard; and to propose a draft of an International Standard which is based on Japanese Industrial Standard.

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Protective clothing—Protection against chemicals—Determination of resistance of protective clothing materials to permeation by liquids and gases

Introduction This Japanese Industrial Standard has been prepared based on the second edition of **ISO 6529** *Protective clothing—Protection against chemicals—Determination of resistance of protective clothing materials to permeation by liquids and gases* published in 2001 with some modifications of the technical contents.

The portions underlined with dots are the matters modified from the original International Standard. A list of modifications with the explanations is given in Annex 1 (informative).

1 Scope This Standard describes laboratory test methods that enable a determination of the resistance of materials used in protective clothing to permeation by liquid or gaseous chemicals under the conditions of either continuous or intermittent contact.

Remarks 1 Method A (see 8.3) is applicable to the testing of liquid chemicals, either volatile or soluble in water, expected to be in continuous contact with the protective clothing material.

Method B (see 8.4) is applicable to the testing of gaseous chemicals expected to be in continuous contact with the protective clothing material.

Method C (see 8.5) is applicable to the testing of liquid chemicals or gaseous chemicals, either volatile or soluble in water, expected to be in intermittent contact with the protective clothing material.

- 2 These test methods assess only the permeation resistance of protective clothing material under laboratory conditions, and do not stimulate such materials under all conditions. The use of test data should therefore be restricted to comparative assessment of the performance of the protective clothing material.
- 3 These test methods address only the performance of materials or certain material constructions (e.g. seams) used in protective clothing. These test methods do not address the design, overall construction and components, or interfaces of garments or other factors which may affect the performance of the protective clothing.
- 4 The International Standard corresponding to this Standard is as follows.

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and JIS are IDT (identical), MOD (modified), and NEQ (not equivalent) according to ISO/IEC Guide 21.

ISO 6529 : 2001 *Protective clothing—Protection against chemicals—Determination of resistance of protective clothing materials to permeation by liquids and gases (MOD)*

2 Normative references The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. If the indication of the year of coming into effect or the year of publication is given to these referred standards, only the edition of the indicated year constitutes the provision of this Standard but the revision and amendment made thereafter do not apply. The normative references without the indication of the year of coming into effect or the year of publication apply only to the most recent edition (including amendments).

JIS K 6404-2-2 *Testing methods for rubber-or plastics-coated fabrics—Determination of roll characteristics—Part 2: Methods for determination of the total mass per unit area, coating mass per unit area, and mass per unit area of the substrate*

Remarks : **ISO 2286-2** *Rubber-or plastics-coated fabrics — Determination of roll characteristics—Part 2: Methods for determination of total mass per unit area, mass per unit area of coating and mass per unit area of substrate* is identical with the said standard.

JIS K 6404-2-3 *Testing methods for rubber-or plastics-coated fabrics—Determination of roll characteristics—Part 3 : Method for determination of thickness*

Remarks : **ISO 2286-3** *Rubber-or plastics-coated fabrics — Determination of roll characteristics—Part 3: Method for determination of thickness* is equivalent to the said standard.

JIS L 0105:1994 *General principles of physical testing methods for textiles*

Remarks : **ISO 139** *Textiles —Standard atmospheres for conditioning and testing* is equivalent to the said standard.

JIS L 1096:1999 *Testing methods for woven fabrics (Annex 3 and Annex 9)*

Remarks : **ISO 3801** *Textiles—Woven fabrics—Determination of mass per unit length and mass per unit area* and **ISO 5084** *Textiles—Determination of thickness of textiles and textile products* are equivalent to the said standard.

JIS T 8115:2005 *Protective clothing for protection against chemicals —Classification, labelling and performance requirements*

Remarks : **ISO/FDIS 16602:2004** *Protective clothing for protection against chemicals—Classification, labelling and performance requirements* is equivalent to the said standard.

JIS Z 9015-1:1999 *Sampling procedures for inspection by attributes—Part 1: Sampling plants indexed by acceptable quality level (AQL) for lot-by-lot inspection*

Remarks : **ISO 2859-1** *Sampling procedures for inspection by attributes—Part 1: Sampling schemes indexed by acceptable quality limit (AQL) for lot-by-lot inspection* is identical with the said standard.

3 Terms and definitions For the purposes of this Standard, the definitions given in JIS T 8115 and the following definitions apply.

- a) **analytical technique** procedure whereby the concentration of a chemical in a collection medium is quantitatively determined

Remarks : Analytical techniques are often specific to individual chemical and collection-medium combinations.

Examples : Applicable analytical techniques can include ultraviolet (UV) and infrared (IR) spectrophotometry, gas and liquid chromatography, pH measurement, ion chromatography, conductimetry, colorimetry, atmospheric analytical detector tubes and radionuclide tagging/detection counting.

- b) **breakthrough detection time** elapsed time measured from the start of the test to the sampling time that immediately precedes the sampling time at which the test chemical is first detected

The breakthrough detection time is not the actual time passed but the last sampling time preceding the breakthrough (see figure 1).

Remarks : The breakthrough detection time is dependent on the sensitivity of the method and the frequency of sampling (the interval between sampling times).

- c) **closed-loop** testing mode in which the collection medium volume is fixed

Remarks : The collection medium volume may change slightly from sampling without replacement of the sampled collection medium.

- d) **collection medium** liquid or gas that does not affect the measured permeation and in which the test chemical is freely soluble or adsorbed to a saturation concentration greater than 0.5 % by mass or by volume

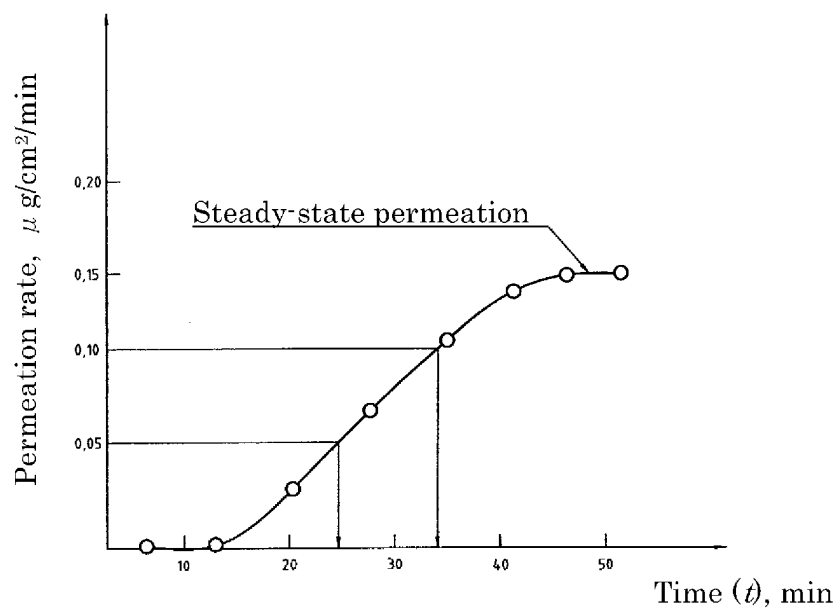
- e) **contact time** in an intermittent contact test, the duration that the challenge-side chamber of the permeation cell contains test chemical during each cycle

- f) **cumulative permeation mass** total amount of chemical that permeates during a specified time from the time the protective clothing material specimen is first contacted with the test chemical

Remarks 1 Quantification of cumulative permeation enables the comparison of permeation behaviour under different intermittent and continuous-contact conditions.

2 The measurement of cumulative permeation may depend on the sensitivity of the permeation-test system.

- g) **cycle time** in an intermittent contact permeation test, the interval of time from the start of one contact period to the start of the next contact period



Remarks : The breakthrough detection time for a method sensitivity of $0.05 \mu \text{ g/cm}^2/\text{min}$ is actually 23 min but would be reported at 20 min, which corresponds to the last sampling time preceding the test. The normalized breakthrough detection time at a normalization permeation rate of $0.1 \mu \text{ g/cm}^2/\text{min}$ is actually 33 min, but similarly would be reported at 28 min, which corresponds to the preceding sampling time. The steady-state permeation rate is approximately $0.15 \mu \text{ g/cm}^2/\text{min}$.

Figure 1 Breakthrough detection time

- h) **degradation** deleterious change in one or more physical properties of a protective clothing material
- i) **minimum detectable mass permeated** smallest mass of test chemical that is detectable with the test system

Remarks : This value is not necessarily the intrinsic limit of detection for the analytical instrument.

- j) **minimum detectable permeation rate** lowest rate of permeation that is measurable with the test system

Remarks : This value is not necessarily the intrinsic limit of detection for the analytical instrument.

- k) **normalization permeation mass** permeation mass used for determining the normalized breakthrough detection time in a closed-loop permeation test

Remarks : This test method provides two choices of normalization permeation mass at $0.25 \mu \text{ g/cm}^2$ or $2.5 \mu \text{ g/cm}^2$.

- l) **normalization permeation rate** permeation rate used for determining the normalized breakthrough detection time in an open-loop permeation test

Remarks : This test method provides two choices of normalization permeation rates: $0.1 \mu \text{ g/cm}^2/\text{min}$ or $1.0 \mu \text{ g/cm}^2/\text{min}$.

- m) **normalized breakthrough detection time** in an open-loop system, time at which the permeation rate reaches the normalization permeation rate (see figure 1)
- n) **normalized breakthrough detection time** in a close-loop system, time at which the mass of chemical permeated reaches the normalization permeation mass
- o) **open-loop** testing mode in which fresh collection medium flows continuously through the collection chamber of the test cell and is not reused or recycled
- p) **penetration** flow of a chemical through closures, seams, porous materials, or other imperfections in a protective clothing material on a non-molecular level
- q) **permeation** process by which a chemical moves through a protective clothing material, involving the sorption of molecules of the chemical into the contacted (outside) surface of a material; diffusion of the sorbed molecules in the material; and desorption of the molecules from the opposite (inside) surface of the material
- r) **permeation mass** quantity of test chemical that passes through the protective clothing material within a given time
- s) **permeation rate** quantity of test chemical that passes through the protective clothing material for a given exposed surface area per unit time
- t) **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
- u) **purge time** in an intermittent contact test, time immediately following the termination of the contact time when the test chemical is removed from the challenge-side chamber and air or nitrogen is blown over the outside surface of the protective clothing material
- v) **steady-state permeation rate** constant rate of permeation that occurs after breakthrough when the chemical contact is continuous and all forces affecting permeation have reached equilibrium

Remarks : Steady-state permeation may not be achieved during the period for which permeation testing is conducted.

- w) **test chemical** liquid or gas that is used to challenge the protective clothing material specimen

Remarks : The liquid or gas may be either one component (i.e. a neat liquid or gas) or have several components (i.e. a mixture).

4 Principle The protective clothing material specimen acts as a partition between the collection chamber of the test cell, which contains the test chemical, and the challenge-side chamber, which contains the collection medium. The test chemical may be either a liquid or a gas. The protective clothing material specimen may contact the

test chemical either continuously or intermittently depending on the choice of the method used. The collection medium, which may be liquid or gas, is analysed quantitatively for its concentration of the chemical and thereby the amount of that chemical that has permeated the partition is expressed as a function of time after its initial contact with the material. Several different test configurations may be used depending on the choice of the test chemical, collection medium and conditions of the test. By either graphical representation or appropriate calculations, or both, the breakthrough detection time, normalized breakthrough detection time, permeation rate, and cumulative permeation of the test chemical are determined. A group of standard test chemicals which can be used to compare the permeation resistance is given in Annex A. Interlaboratory data for this test method are provided in Annex B.

5 Choice of analytical technique and collection medium

5.1 General The combination of the analytical technique and the collection medium shall be selected to maximize sensitivity for the detection of the test chemical and represent actual occupational conditions as closely as possible.

5.2 Gaseous collection medium The gaseous collection medium shall be either dry air or a dry, non-flammable inert gas, or other gases which do not interfere with the detection of the test chemical and are of sufficiently high purity as not to interfere with the permeation process or analytical procedure.

Examples : Nitrogen or helium

Remarks : The gaseous collection medium shall be used, under continuous flow conditions, for the collection of permeating molecules that are capable of vaporizing from the test liquid under the conditions of the test in sufficient quantities for analysis.

5.3 Liquid collection medium The liquid collection medium shall be either water or another liquid which does not influence the resistance of the protective clothing material to permeation.

Remarks : The liquid collection medium shall be used for the collection of diffused molecules of low volatility that are soluble in the collecting medium under the conditions of the test in sufficient quantities for analysis.

5.4 Other collection medium Other collection medium such as solid sorbents may be used when suitable collection efficiencies are demonstrated for the test chemical being used.

6 Apparatus

6.1 Thickness gage, suitable for measuring thickness to the nearest 0.02 mm, as specified in JIS K 6404-2-3 or Annex 9 of JIS L 1096, and used to determine the thickness of each protective clothing material specimen tested.

6.2 Analytical balance, capable of being read to the nearest 0.01 g.

6.3 Permeation test cell, consisting of a two-chambered cell for contracting the specimen with the test chemical on the specimen's normal outside surface (clothing exterior) and with a collection medium on the specimen's normal inside surface

(clothing interior).

Remarks : Permeation test cells may be designed for testing either liquid test chemicals or gaseous test chemicals. However, alternative permeation test cells may also be used.

6.3.1 Permeation test cell for liquid test chemicals, capable of accommodating liquid chemicals, constructed from two end-fitting sections of straight glass pipe, each nominally sized to either a 25 mm or 51 mm inside diameter (see figure 2). Materials other than glass may be used for tests involving chemicals incompatible with glass (e.g. hydrofluoric acid).

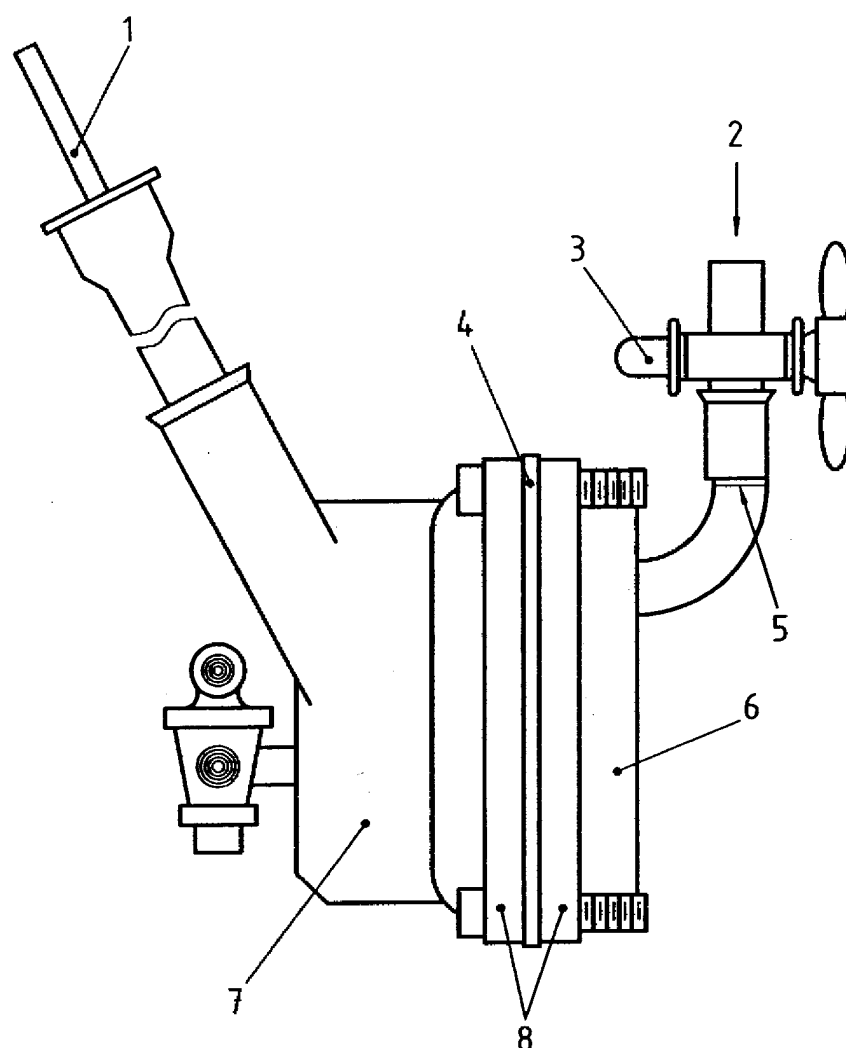
a) Permeation test cells made from glass shall be arranged as follows:

- 1) One end of each glass section shall be sealed closed (for example, with a glass disk equivalent in quality to that of the glass of the original sections).
- 2) The opposite end of each glass section shall retain the “as-manufactured” flared end.
- 3) Inlet and outlet ports with appropriate stopcock valves shall be added to each glass section as shown in figure 2.
- 4) When assembled, the two glass sections shall be joined horizontally by flanges and a gasket shall be used at the joint. A second gasket may be used on the other side of the test specimens if necessary, to obtain a proper seal.

Example : PTFE gasket material

- 5) In closed-loop tests where increased analytical sensitivity is required, a shorter length of glass pipe may be used to contain the collection medium. This reduces the contained volume and increases the ratio of material specimen area to the collection medium volume. In open-loop tests, lower collection medium flow rates will increase the system sensitivity by lowering the minimum detectable permeation rate.
- b) The challenge-side chamber may be modified to include an additional outlet port (with stopcock) positioned downward, opposite the liquid chemical inlet port. Such a modification will facilitate the repeated addition and removal of liquid test chemicals during intermittent testing.
- c) The protective clothing material specimen is positioned between the flared ends of two glass sections that compose the test cell. When the specimen is in place, the test cell is divided into two chambers.

Remarks : Sources for permeation test cell parts are provided in Annex C.



- | | |
|----------------------------|--------------------------------------|
| 1 Replaceable stirring rod | 5 Fill level |
| 2 Test chemical inlet | 6 Challenge-side chamber |
| 3 Stop cock adapter | 7 Collection chamber (sampling side) |
| 4 Gasket | 8 Aluminium flanges |

Figure 2 Permeation test cell for liquid test chemicals

6.3.2 Permeation test cell for gaseous test chemicals (see figure 3), capable of accommodating gaseous chemicals, identical to the liquid permeation test cell except that, with reference to figure 2, two collection medium sections are used. Thus, the gaseous chemical can be circulated from its reservoir through the challenge-side chamber. Flow shall be such that the composition and concentration of the gas in the test chamber does not change with time and the test gas in the chamber is well mixed.