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**Protective clothing — Protection
against gaseous and liquid chemicals
— Determination of resistance of
protective clothing to penetration by
liquids and gases**

ICS 13.340.10

Reference number : JIS T 8032 : 2005 (E)

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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 as the result of 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 17491:2002** *Protective clothing—Protection against gaseous and liquid chemicals—Determination of resistance of protective clothing to penetration 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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In the event of any doubts arising as to the contents,
the original JIS is to be the final authority.

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Contents

	Page
Introduction	1
1 Scope.....	1
2 Normative references.....	1
3 Terms and definitions	2
4 Test methods.....	3
5 Method A—Internal pressure test	4
5.1 Principle.....	4
5.2 Apparatus	4
5.3 Procedure.....	4
5.4 Test report.....	7
6 Method B—Aerosol and gaseous inward leakage test	7
6.1 Principle.....	7
6.2 Test agents and test subjects	7
6.3 Apparatus	10
6.4 Procedure.....	11
6.5 Calculation.....	13
6.6 Test report.....	13
7 Method C—Liquid jet test	13
7.1 Principle.....	13
7.2 Test agent and test subject	13
7.3 Apparatus	14
7.4 Preparation of samples for the jet test	15
7.5 Procedure.....	15
7.6 Test report.....	16
8 Method D—Liquid spray test	16
8.1 Principle.....	16
8.2 Test agent and test subject	16
8.3 Apparatus	17
8.4 Preparation of samples for the spray test.....	20
8.5 Preparation of the spray application systems	20
8.6 Procedure.....	21
8.7 Test report.....	21
9 Method E—Alternative liquid spray test.....	22
9.1 Principle.....	22
9.2 Test agent and test subject	22

9.3	Apparatus.....	22
9.4	Specimen preparation	23
9.5	Procedure	23
9.6	Test report	27
10	Method F—Mist test	27
10.1	Principle	27
10.2	Test agent and test subject.....	27
10.3	Apparatus.....	27
10.4	Preparation of samples for the spray test	28
10.5	Preparation of the spray application systems.....	29
10.6	Procedure	29
10.7	Test report	29
Annex A (informative)	Bibliography.....	31
Annex 1 (informative)	Comparison table between JIS and the corresponding International Standard.....	32

Protective clothing—Protection against gaseous and liquid chemicals—Determination of resistance of protective clothing to penetration by liquids and gases

Introduction This Japanese Industrial Standard has been prepared based on the first edition of *ISO 17491 Protective clothing—Protection against gaseous and liquid chemicals—Determination of resistance of protective clothing to penetration by liquids and gases* published in 2002 with some modifications of the technical contents.

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

1 Scope This 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 range in the level of severity.

NOTE : The International Standard corresponding to this Standard is as follows.

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

ISO 17491:2002 *Protective clothing—Protection against gaseous and liquid chemicals—Determination of resistance of protective clothing to penetration 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 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 there- after do not apply. The normative references without the indication of coming into effect apply only to the most recent edition (including amendments).

JIS T 8005 *Protective clothing—General requirements*

NOTE : ISO 13688:1998 *Protective clothing—General requirements* is equivalent to the said standard.

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

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

EN 136:1998 *Respiratory protective devices—Full face masks—Requirements, testing, marking*

EN 149:1991 *Respiratory protective devices—Filtering half masks to protect against particles—Requirements, testing, marking*

EN 12941:1998 *Respiratory protective devices—Powered filtering devices incorporating a helmet or a hood—Requirements, testing, marking*

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

- a) **assemblage** permanent fastening between two or more different garments, or between chemical protective clothing and accessories, such as hood, gloves and footwear
- b) **calibrated stain** a defined minimum area, generated by dropping a specified quantity of test agent onto an absorbent coverall in order to determine the resistance of the finished chemical protective clothing to penetration by chemicals
NOTE : The calibrated stain is used to measure liquid penetration during spray and jet testing of chemical protective clothing.
- c) **chemical protective clothing** individual garment or combined assembly of garments, worn to provide protection against exposure to or contact with chemicals
- d) **connection** generic designation of assemblage or joint
- e) **degradation** deleterious change in one or more physical properties of a protective clothing material due to contact with chemicals
- f) **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
- g) **gas-tight suit** chemical protective clothing that covers the whole of the body, provided with a feature capable of retaining air-tightness inside the clothing and designed so as to prevent chemicals from penetrating into the clothing
- h) **joint** non-permanent fastening between two different garments, or between chemical protective clothing and accessories such as hood, gloves and footwear
- i) **penetration** flow of a chemical through closures, seams, porous materials, and other imperfections in a protective clothing material on a non-molecular level
- j) **permeation** process by which a chemical contacted (outside) surface of a material is sorbed into the material and diffused on a molecular level inside the material and then desorbed from opposite (inside) surface of the material
- k) **protective clothing material** any material or combination of materials used for chemical protective clothing (hereafter referred to as “materials”)
- l) **undergarments** clothing worn next to the body surface, beneath the other clothing

4 Test methods The six integrity test methods specified by this Standard are as follows:

- a) **Method A—Internal pressure test** This method specifies a method 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 materials of construction.
- b) **Method B—Inward leakage test** This method specifies two different methods for determining the inward leakage of chemical protective clothing in a gaseous (or aerosol) environment. The procedure provides an evaluation of chemical protective clothing integrity, particularly leakage in the breathing zone, under dynamic conditions through the use of human subjects.
- c) **Method C—Liquid penetration-resistant test (liquid Jet test)** This method 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 where there is a risk of exposure to a forceful projection of a liquid chemical and intended to be resistant to penetration under conditions which require total body surface cover but not gas-tight clothing.
- d) **Method D—Liquid penetration-resistant test (liquid spray test)** This method specifies a method for determining the resistance of chemical protective clothing to penetration by sprays of liquid chemicals. This procedure applies to protective clothing 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 intended to be resistant to penetration under conditions which require total body surface cover but not gas-tight clothing.
- e) **Method E—Liquid penetration-resistant test (alternative liquid spray test)** This method specifies an alternative method to method D for determining the resistance of chemical protective clothing to penetration by sprays of liquid chemicals. Method E differs from Method D in that it uses a static mannequin instead of a test subject, it also uses a different spray configuration and duration (1 h compared to 30 min for Method D).
- f) **Method F—Mist penetration-resistant test (mist test)** This method is a modification of Method D where the spray has been modified to light spray or mist by use of different nozzles and spray conditions and is intended for partial body protective clothing where the likelihood of splash exposure is low.

NOTE : Methods C, D, E and F are not appropriate for evaluating the permeation or penetration of liquid chemicals through the material from which the clothing is made.

5 Method A—Internal pressure test

5.1 Principle After the clothing 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 A1 uses an inflation pressure of 1 250 Pa and a test pressure of 1 000 Pa. Method A2 uses an initial pressure of 1 750 Pa, a dwell test pressure of 1 700 Pa and a test pressure of 1 650 Pa. Method A1 is considered the minimum internal pressure test, but Method A2 provides a more rigorous determination of clothing gas-tight integrity.

NOTE : 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 material of construction, thereby enabling the test method to be capable of detecting very small imperfections, e.g. holes, splits or tears.

5.2 Apparatus The apparatus to be used for the test shall be as follows.

5.2.1 Source of compressed air It is capable of supplying air within the temperature range of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$.

5.2.2 Pressure-measuring device The device is capable of measuring up to $1\,750\text{ Pa} \pm 30\text{ Pa}$ with a sensitivity (readability) of 50 Pa.

5.2.3 Vent valve-closure components Such components may be plugs or other means that are to be supplied for test purposes by the manufacturer.

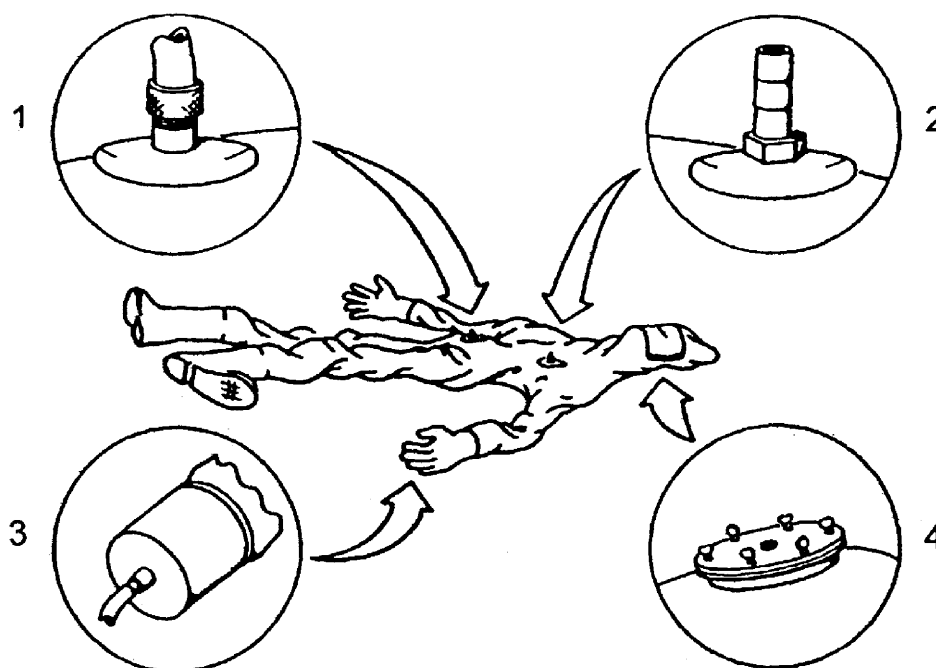
5.2.4 Stop clock or appropriate timing device They are capable of measuring to the nearest second.

5.3 Procedure The test procedure shall be as follows.

5.3.1 General

- a) Lay out the chemical protective clothing 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, such as an area for testing that is away from direct sunlight, open doors, drafts, heating and air conditioning registers.
- b) Perform a visual inspection of the chemical protective clothing.
 - 1) Check the chemical protective clothing for seam integrity by visually examining the seams and gently pulling on the seams.
 - 2) Ensure that all air supply lines, fittings, visor or faceshield, zippers, and valves are secure and show no signs of deterioration.
- c) Remove any creases and folds in the clothing as far as practicable.
- d) Leave the clothing for a minimum of 1 h at ambient temperature $\pm 3\text{ }^{\circ}\text{C}$

- e) Make an inflation connection using on the techniques illustrated in figure 1. Attach the pressure-measuring device (5.2.2) to the chemical protective clothing or inflation system.
- f) Carefully blank off the valves and other openings on the chemical protective clothing with appropriate means of closure supplied by the manufacturer.
- g) Choose either Method A1 or Method A2 as a test method.



- 1 Airline connector or inflation couple
- 2 Clothing venting-valve adapter
- 3 Removable gloves
- 4 Face-plate seal

Figure 1 Typical examples of clothing modification to permit inflation

5.3.2 Method A1—Minimum procedure

- a) Using compressed air (5.2.1), inflate the clothing carefully to a pressure of $1\,250\text{ Pa} \pm 50\text{ Pa}$.
- b) Maintain the pressure at $1\,250\text{ Pa} \pm 50\text{ Pa}$ for at least 1 min by addition of air, if necessary, and at the same time ensure that any creased areas are unfolded and that the clothing is stretched as appropriate.

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

- c) After the period of at least 1 min has elapsed, adjust the pressure in the clothing to $1\,000\text{ Pa} \pm 25\text{ Pa}$.

- d) Allow a further 4 min to elapse. Note and record the ending pressure in the clothing in pascals (Pa). Pay careful attention to the cleanliness and the refitting of valves which have been obstructed or removed to carry out the test, to ensure that they function satisfactorily after the test.
- e) If the chemical protective clothing shows a 20 % or more drop in pressure [$(\text{test pressure} - \text{ending pressure}) / \text{test pressure} \times 100$], check for leaks by inflating the clothing to $1\,250\text{ Pa} \pm 50\text{ Pa}$ and by brushing or wiping the entire chemical protective clothing (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 clothing for the formation of soap bubbles, which are an indication of a leak. Repair all identified leaks in accordance with specific manufacturer instructions, if permitted.

Information : Any commercially available, high sudsing soap solution such as children's bubble, has been found to offer satisfactory performance for this purpose.

- f) Retest the repaired chemical protective clothing as specified in 5.3.1 a) to f) and 5.3.2 a) to d) (if it originally showed a 20 % or more drop in pressure, and was subsequently repaired).

5.3.3 Method A2—Rigorous procedure

- a) Using compressed air, inflate the clothing carefully to a initial pressure of $1\,750\text{ Pa} \pm 50\text{ Pa}$
- b) Maintain the pressure at $1\,700\text{ Pa} \pm 50\text{ Pa}$ for 10 min by addition of air, if necessary, and at the same time ensure that any creased areas are unfolded and that the clothing is stretched as appropriate.

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

- c) After the period of 10 min has elapsed, adjust the pressure in the clothing to $1\,650\text{ Pa} \pm 25\text{ Pa}$.
- d) Allow a further 6 min to elapse. Note and record the ending pressure in the clothing in pascals (Pa). Pay careful attention to the cleanliness and the refitting of valves which have been obstructed or removed to carry out the test, to ensure that they function satisfactorily after the test.
- e) If the chemical protective clothing shows unacceptable leakage as defined by the required performance, check for leaks by inflating the clothing to $1\,700\text{ Pa} \pm 50\text{ Pa}$ and by brushing or wiping the entire chemical protective clothing (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 clothing for the formation of soap bubbles, which are an indication of a leak. Repair all identified leaks in accordance with specific manufacturer instructions, if permitted.

Information : Any commercially available, high sudsing soap solution such as children's bubble, has been found to offer satisfactory performance for this purpose.

- f) Retest the repaired chemical protective clothing as specified in 5.3.1 a) to f) and 5.3.3 a) to d)

5.4 Test report The test report shall include the following information.

- a) a reference to this Standard, i.e. **JIS T 8032**
- b) the method used, i.e. Method A1 or Method A2;
- c) the manufacturer's name and/or supplier's name or any identifying mark;
- d) the pressure recorded in 5.3.2 d) or 5.3.3 d) and the test temperature;
- e) any further qualifying remarks and observations;
- f) the results of any retesting, after repair of the clothing.

6 Method B—Aerosol and gaseous inward leakage test

6.1 Principle The subject wearing the clothing under test, walks on a treadmill over which there is an enclosure. Through this enclosure flows a constant concentration of the test agent, either sodium chloride (NaCl) using Method B1 or sulfur hexafluoride (SF₆) using Method B2. The air inside the clothing is sampled to determine the test agent content. The sample is extracted through a probe placed inside the clothing. Another probe measures the pressure inside the clothing. The airflow rate to the clothing is adjusted and maintained at the manufacturer's minimum design flow rate. If the clothing is not outfitted with an external continuous flow air supply, then the airflow rate into the clothing shall be at the rate of sampling air that is withdrawn from the clothing. For a typical arrangement, see figure 2 and figure 3.

NOTE : Method B1 simulates an aerosol challenge while Method B2 simulates a gaseous challenge.

6.2 Test agents and test subjects The test agents and test subjects shall be as follows.

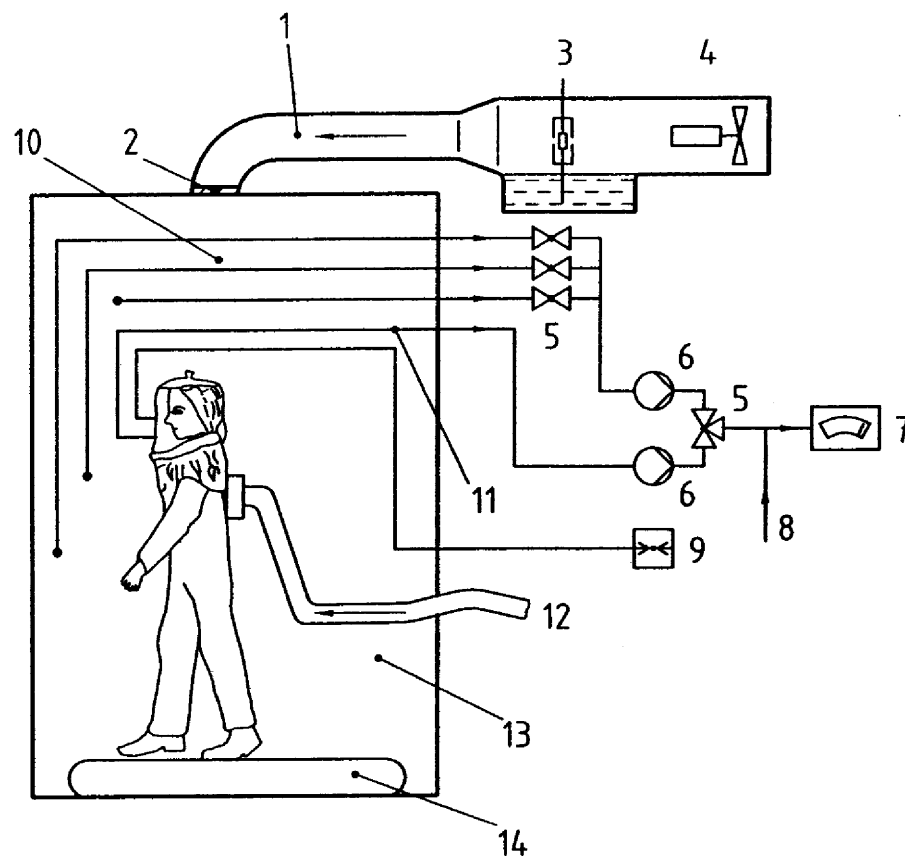
6.2.1 Test agents

6.2.1.1 Method B1 Sodium chloride test agents

The mean sodium chloride concentration within the enclosure shall be as described in 8.16.3.2.2 of EN 136:1998.

6.2.1.2 Method B2 Sulfur hexafluoride test agents

This method employs sulfur hexafluoride as the test gas. The subject wearing the clothing under test stands with his suited body surrounded by the SF₆ test atmosphere (see figure 3). Accurate determinations of leakage shall be possible within the range for 0.001 % to approximately 20 % depending on the test challenge atmosphere. It is recommended to use a test atmosphere at 0.1 % SF₆ (by volume) since SF₆ can build up inside the clothing. SF₆ is not to be used for full clothing utilizing filters as exhaust assemblies unless the clothing exhaust assemblies are connected to an atmosphere free of the challenge agent during testing.



- 1 Duct
- 2 Baffle
- 3 Atomizer
- 4 Fan
- 5 Valves
- 6 Pump
- 7 Photometer
- 8 Additional air input
- 9 Manometer
- 10 Enclosure samples
- 11 Breathing zone samples
- 12 Breathing air supply
- 13 Enclosure
- 14 Treadmill

Figure 2 Typical arrangement of inward leakage test using sodium chloride aerosol