INTERNATIONAL STANDARD

ISO
8194
First edition
1987-06-01

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION
ORGANISATION INTERNATIONALE DE NORMALISATION
МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ

Radiation protection — Clothing for protection against radioactive contamination — Design, selection, testing and use

Protection contre les rayonnements — Vêtements de protection contre la contamination radioactive — Conception, choix, essais et utilisation

Reference number
ISO 8194 : 1987 (E)

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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 8194 was prepared by Technical Committee ISO/TC 85, *Nuclear energy*.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

Contents

This page intentionally left blank

Radiation protection — Clothing for protection against radioactive contamination — Design, selection, testing and use

1 Scope and field of application

This International Standard gives the characteristics of clothing protecting the wearer against radioactive contamination brought about by contact with liquid or solid substances or by atmospheric pollutants, such as solid particles, mist, gases or vapours.

The International Standard applies to two types of clothing: firstly, ventilated-pressurized garments; secondly, unventilated-unpressurized garments.

A test method according to which any new type of garment can be assigned a protection factor that makes it easier for the user to make a choice is described in annex A.

Annexes B and C give methods for measuring leak-tightness and air supply flow rates of ventilated-pressurized garments.

Annex F gives, for guidance purposes only, recommendations for choosing protective clothing.

2 References

ISO 3873, *Industrial safety helmets*.

IEC Publication 651, *Sound level meters*.

3 Definitions

3.1 ventilated-pressurized garments: Protective clothing made from impermeable material which is supplied with breathable air ensuring internal ventilation and overpressure.

These garments provide protection for the respiratory tract and the whole body (head, hands and feet) or only the upper part of the body.

3.2 unventilated-unpressurized garments: Protective clothing made from impermeable or permeable material without an internal ventilation device.

These garments are not intended to provide protection for the respiratory tract but they provide protection for other parts of the body.

3.3 protection factor for clothing: The ratio of the average concentrations of pollutant measured in the ambient atmosphere and inside the helmet of the suit at the point where the wearer draws breath.

The concentrations taken into account are the average concentrations recorded during a standardized test (see A.11.8).

4 Ventilated-pressurized garments

4.1 Classification

4.1.1 General

Ventilated-pressurized clothing is divided into four classes, depending on the way in which the air is released.

Recommendations as to the selection of garment types for different operating conditions are given in annex F.

The four classes are given in 4.1.2 to 4.1.5.

4.1.2 Class I: Ventilated-pressurized clothing with a channelled outlet outside the shield

In class I clothing, the exhaust air is channelled and released at a distance from the ambient atmosphere (e.g. an argon atmosphere) so that the composition of the latter is not affected.

4.1.3 Class II: Ventilated-pressurized clothing with a controlled and channelled outlet

In class II clothing, the exhaust devices (valves, perforations, particulate and gas filters) are fitted with a channel which directs the exhaust air over a specified distance so as to prevent, by ensuring a fast enough exhaust speed, back-diffusion of pollutants.

4.1.4 Class III: Ventilated-pressurized clothing with a controlled outlet

In class III clothing, the air is released through exhaust devices (valves, perforations, particulate and gas filters) into the surrounding atmosphere.

4.1.5 Class IV: Ventilated-pressurized clothing with an uncontrolled outlet

In class IV clothing, the air escapes freely into the surrounding atmosphere (through belt, sleeves, etc.).

4.2 Leak-tightness

The main purpose of ventilated-pressurized garments is to protect the wearer, satisfactorily, from a contaminated atmosphere. This is achieved partly by making up the garment, preferably, in one piece, and partly by having an air-feed at overpressure which purges and inhibits pollutants from leaking into the garment. A method for measuring the leak-tightness of ventilated-pressurized garments is given in annex B.

4.3 Manufacturing materials

4.3.1 The materials used to make the clothing shall be impermeable to the radioactive pollutants (see 4.7) and shall not be adversely affected by other substances in the working environment or by severe climatic conditions. The materials shall be adaptable to the production of the protective clothing and to its disposal after use.

The choice of materials shall be made after account has been taken of the following factors:

a) mechanical factors, e.g. tearing, wear, perforation, etc.;

b) thermal factors, e.g. incandescent particles, high specific activity particles, etc.;

c) chemical factors, e.g. attack by solvents, particles of corrosive products, etc.;

d) electrical factors, e.g. conductance, etc.;

e) risk of explosion, e.g. static electricity, etc.

4.3.2 Materials which might come into contact with the skin shall be smooth and free from irritant substances or substances known to be allergenic, and, while in use (in particular when in contact with sweat) or in storage, they shall not release chemical agents in amounts dangerous for the human body.

4.3.3 The materials, surface and finish of various components in the clothing intended for re-use shall be easily decontaminated and/or cleaned after use.

4.3.4 The flammability of materials shall be clearly indicated. The flammability performance of the materials which the clothing is made from shall conform with requirements laid down by national legislation in force, if such exists.

4.3.5 Garments shall be made of materials which permit them to be stored for at least two years under the conditions recommended by the manufacturer. Such conditions may include protection against exposure to light, particularly UV, and storage at normal room temperatures.

4.4 Manufacture

4.4.1 Design

The design and size of a garment shall be such that they provide the wearer with a reasonable degree of comfort and do not seriously impede movement; this may be achieved by minimizing the bulk of the garment and by avoiding protruding components which are likely to prevent free movement in confined working spaces.

4.4.2 Mass

The mass of the garment shall be as low as practicable in order to ensure the wearer's safety and comfort, and reduce physical effort.

4.4.3 Seal

The design of any sealing device shall minimize the risk of contamination when the wearer is removing the garment.

4.4.4 Headgear

4.4.4.1 The headgear, which is the part of the garment which covers the wearer's head, may be flexible or rigid.

4.4.4.2 The window in the headgear shall ensure a wide enough field of vision to allow the wearer to carry out the necessary work. Optical defects shall be kept to a minimum.

4.4.4.3 Means shall be provided to prevent the window from misting over.

4.4.4.4 In cases where the rigid headgear is designed to provide protection against impacts, it shall comply with ISO 3873.

4.4.4.5 The base of the rigid headgear shall have a leak-tight coupling connecting it to the garment to make it easy to remove the headgear for decontamination, repair or replacement.

4.4.5 Gloves

Gloves shall either form an integral part of (i.e. welded to) the garment or be detachable (care shall be taken to ensure the leak-tightness of fixing). In all cases, the choice of gloves and, where applicable, the number of gloves worn on top of each other will depend on the nature of the work to be carried out.

4.4.6 Footwear

Footwear shall either form an integral part of (i.e. welded to) the garment or be detachable (care shall be taken to ensure the leak-tightness of fixing). In all cases, the choice of footwear will depend on the nature of the work to be carried out.

4.5 Breathing air supply and internal ventilation

4.5.1 General

The air supply to ventilated clothing shall not only meet the wearer's breathing requirements but also those of his thermoregulation.

4.5.2 Air supply flow rate

The air supply flow rate shall be between 9 and 15 m^3/h (between 150 and 250 l/min) (n.t.p.)[1] under normal conditions of use[2]. For some severe operating conditions (high ambient temperature, mild compressed air, high activity of the wearer), the air supply flow rate shall be capable of reaching 30 m^3/h (500 l/min).

A method for measuring the air supply flow rate of pressurized-ventilated clothing is given in annex C.

4.5.3 Regulating the flow rate

The air flow rate is regulated either by the wearer or from a control panel. This enables the flow rate of ventilation air to be adjusted to changes in the wearer's activity, the ambient temperature and the pressure of the air source. The regulating valve of the garment shall not be cumbersome and shall be robust and decontaminable. The valve shall be positioned within easy reach of the wearer and away from the headgear because of the noise it may produce. The tap shall be fitted with a closure-limiting device or a by-pass in order to guarantee the wearer the minimum flow of breathable air necessary, i.e. 3,6 m^3/h (60 l/min) when the tap is accidentally closed.

4.5.4 Overpressure in the garment

The pressure drop of the ventilation air through the exhaust creates overpressure in the clothing.

Overpressure contributes to the efficiency of a garment by inhibiting pollutants from leaking into the garment as a result of defects in the leak-tightness of the clothing (perforations, porosity, faulty seals, etc.).

Normal overpressure in a garment shall be between 0,1 and 0,3 kPa (1 and 3 mbar), the measurement being taken on a garment the volume of which is constant (immobile wearer) and which is supplied with 12 m^3/h (200 l/min) (n.t.p.).

If the wearer makes rapid movements (stretching, bending down, etc.), the dead volume of the garment tends to be reduced in a short period of time resulting in a high flow rate through the escape devices. If the latter cannot absorb these flow rate peaks, the resulting overpressure may cause discomfort in the wearer's eardrums.

The overpressure in a garment measured under the above conditions, using a manometer with a suitable response time, shall not exceed 1,2 kPa (12 mbar) (see annex A).

4.5.5 Characteristics of the breathable air

The air supply to the ventilated garment shall be as similar as possible to that of normal atmospheric air.

In the absence of national legislation, the maximum permissible values of the pollutants are as follows:

- carbon monoxide (CO) : 10 ppm (parts per million in volume)
- carbon dioxide (CO_2) : 500 ppm
- mineral oil (vapour) : 0,5 mg/m^3
- dust : 0,5 mg/m^3

The impurities of breathable air shall be kept to a minimum, but in any event shall not exceed the occupational exposure limit (OEL).

4.5.6 Air conditioning

When worn in areas where the temperature is considerably different from normal, clothing shall be supplied with heated or cooled air, as appropriate.

In the case where the ambient air temperature is higher than normal and where strenuous physical activity is involved, thermal stress can be reduced by drying the air supply.

4.5.7 Characteristics of air hoses

The flexible hoses used for the compressed breathing air supply of ventilated-pressurized garments shall be

- manufactured from a material that does not affect the quality of the air for breathing;
- resistant to the maximum service pressure;
- resistant to longitudinal tension;
- resistant to kinking;
- resistant to crushing;
- as light as possible.

4.5.8 Internal ventilation device

Internal ventilation shall provide as homogeneous and constant a renewal of air as possible to all areas of the garment, whatever the movements and positions of the wearer. The air inlet into the headgear shall provide efficient ventilation of the facial area so as to dilute and carry away the expired air comprising carbon dioxide and water vapour (so as to avert the danger of recycling the carbon dioxide and misting of the visor).

Examples of this device are given in annex D.

4.5.9 Exhaust devices

These devices are intended to let air escape out of the garment with a minimum of pressure loss, and either to prevent ambient air from leaking into the garment or to filter ambient air before it leaks into the garment, so as to minimize any pollution.

Examples of exhaust devices are given in annex E. Should there be no exhaust device, the air shall escape freely.

1) n.t.p. : normal temperature and pressure, i.e. 0 °C and 101,3 kPa.
2) Mechanical muscular work rate approximately 50 W; ambient temperature of 25 °C.

4.5.10 Emergency devices

In the event of a breakdown in the air supply, the wearer's safety shall be ensured either by an emergency device, which enables the wearer to breathe for the time it takes to get out of the contaminated area, or by use of filtering respiratory equipment. If this garment is used in an atmosphere on instant exposure to which the wearer's life will be put in jeopardy, the wearer shall be equipped with an emergency self-contained breathing apparatus.

4.6 Sound pressure level and voice transmission

The sound pressure level inside the helmet, resulting from the flow of air, shall be low enough not to inflict any extra fatigue on the wearer.

When the garment is being worn, the sound pressure level at the top of the ear should be less than 80 dB(A), measured using a sound meter of type 1 in accordance with IEC Publication 651 for the maximum flow rate of air intended for the considered garment.

If the garment is fitted with a voice transmission device, with or without wires, the wearer shall, at all times, be in communication with supervisory staff and possibly with other members of the team.

4.7 Protection against tritium

Tritium is an isotope of hydrogen; the tritium molecule has a low mass, is extremely mobile and capable, at ambient temperatures, of passing through thin metallic walls, plastics and elastomers.

By auto-oxidation with the oxygen in the air and isotopic exchange with hydrogen in the atmospheric water vapour, it is capable of transforming itself into tritiated water vapour. As tritiated water behaves in the body in the same way as ordinary water, it is far more dangerous than tritiated gas.

Garments providing protection against tritium shall afford both protection to the respiratory tract by supplying breathable air and protection of the skin by completely isolating the body from the polluted atmosphere. These conditions are satisfied by using ventilated clothing in which

a) the material possesses the satisfactory properties of porosity with regard to molecular tritium and tritiated water vapour;

b) the exhaust devices are fitted at the top with a channel which directs the exhaust air over a specified distance and ensures that the speed at which the air escapes is greater than the back-diffusion speed of tritium;

c) the overall leak-tightness is particularly efficient;

d) the internal ventilation device is capable of providing sufficient, well distributed ventilation, with no dead volumes nor short circuits so that any tritium which may have leaked into the clothing can be diluted and rapidly exhausted from the suit.

4.8 User's instructions

All ventilated-pressurized garments shall be accompanied by the instructions for the user as to how to put the garment on, how to use it, how to remove it, how to minimize the risk of contamination, how to store it, the limiting conditions for use of the garment and any limitations resulting from the nature of the material.

5 Unventilated-unpressurized garments

NOTE — Indications concerning the selection and the conditions of use of these garments are given in annex F.

5.1 Manufacturing materials

5.1.1 Impermeable materials

5.1.1.1 The materials used to make the garment shall be impermeable to the radioactive pollutants.

The choice of materials shall be made after account has been taken of the following factors:

a) mechanical factors, e.g. tearing, wear, perforation, etc.;

b) thermal factors, e.g. incandescent particles, etc.;

c) chemical factors, e.g. attack by solvents, particles of corrosive products, etc.;

d) electrical factors, e.g. conductance, etc.;

e) risk of explosion, e.g. static electricity, etc.

5.1.1.2 Materials which might come into contact with the skin shall be smooth and free from irritant substances or substances known to be allergenic, and, while in use (in particular when in contact with sweat) or in storage, they shall not release chemical agents in amounts dangerous for the human body.

5.1.1.3 The materials, surface and finish of various components of the garments shall be suitable for frequent decontamination by industrial laundry processes or shall be suitable for disposal and economical replacement.

5.1.1.4 The flammability of materials shall be clearly indicated. The flammability performance of the materials which the clothing is made from shall conform with requirements laid down by national legislation in force, if such exists.

5.1.1.5 Garments shall be made of materials which permit them to be stored for at least two years under the conditions recommended by the manufacturer. Such conditions may include protection against exposure to light, particularly UV, and storage at normal room temperatures.

5.1.2 Permeable materials

5.1.2.1 The materials used to make the garment shall provide a degree of protection appropriate to the environment and be suitable for their intended use. The material should be resistant to penetration by solid particles and minimize resuspension of any contamination on the clothing.

The choice of materials shall take due account of the following factors:

a) mechanical factors, e.g. tearing, wear, etc.;

b) thermal factors, e.g. flammability, etc.;

c) chemical factors, e.g. attack by solvents or corrosive products, etc.;

d) electrical factors, e.g. conductance, etc.

e) risk of explosion, e.g. static electricity, etc.

5.1.2.2 Materials which might come into contact with the skin shall be smooth and free from irritant substances or substances known to be allergenic.

5.1.2.3 The type of material used shall be suitable for frequent decontamination by industrial laundry processes, and disposal and economical replacement.

5.2 Manufacture

5.2.1 Design

The design of an unventilated-unpressurized garment shall be such that it reduces, as much as possible, the discomfort of the wearer and avoids protruding components (buttons, sealing devices, pockets, belts, etc.) which might catch in restricted working areas or in elements of moving machinery.[1)]

The garment may comprise one or two pieces, with or without gloves (see 5.2.3), footwear and headgear. The design shall make it easy for a facepiece of respiratory protection apparatus to be worn.

The design of this garment shall also be such that the garment is straightforward for the wearer to put on and take off, and to minimize the risk of contamination.

The design of the garment made from permeable material shall be such that it provides for the ease and comfort of staff wearing it.

If boots and gloves are used separately, turn-downs may be provided for the sleeves and the bottom of the trousers.

5.2.2 Seal

As unventilated-unpressurized garments provide a limited enclosure of the body, their sealing may be improved by the use of adhesive tapes.

The sealing device shall be designed with a view to minimizing the risk of contamination when the wearer is removing the garment.

5.2.3 Gloves

Gloves shall either form an integral part of (i.e. welded to) the garment or be detachable (care shall be taken to ensure the leak-tightness of fixing). In all cases, the choice of gloves and, where applicable, the number of gloves worn on top of each other will depend on the nature of the work to be carried out.

1) When designing clothing to be worn in areas where there is unfenced machinery, various national regulations shall be strictly adhered to.

Annex A

Test method for determining the level of respiratory protection against aerosols of ventilated-pressurized garments

(This annex forms an integral part of the standard.)

A.1 The level of respiratory protection provided by a ventilated-pressurized suit shall be determined by an aerosol test, in which a human being will have to wear the suit, connected to a source of breathable air, in an atmosphere containing the test aerosol.

A.2 For the test, three subjects of different heights within the following ranges (in metres) shall be used:

a) $1,65 \begin{smallmatrix} +0,04 \\ -0,05 \end{smallmatrix}$

b) $1,75 \pm 0,05$

c) $1,85 \begin{smallmatrix} +0,05 \\ -0,04 \end{smallmatrix}$

The test subjects shall select the garment size appropriate to their height.

The height and weight of the three subjects shall be determined and recorded in the test report.

A.3 The rate of leakage of the aerosol into the helmet of the suit worn by the subject shall be measured while the latter performs various exercises (see A.11.2).

A.4 During the test, the air pressure in the breathing space inside the helmet shall be measured; this is carried out using a pressure gauge located in the area of the helmet from which the subject draws breath (the "breathing space") and connected to a suitable air-pressure measuring instrument.

A.5 The atmosphere used for the test is the sodium chloride aerosol or any other solid aerosol with equivalent properties. Accurate results will be obtained only if the aerosol consists of dry salt particles; in order to meet this requirement the relative humidity of the air discharged from the evaporation tube shall be lower than 60 %. The grain size and concentration shall be measured in quartiles by suitable methods. The results shall be recorded.

A.6 Inspection equipment and appropriate accessories shall be used to measure the concentration of aerosol in the test atmosphere and inside the helmet of the ventilated-pressurized suit in the test subject's breathing space.

An appropriate recorder shall be used to record the concentrations.

A.7 The chamber containing the test atmosphere shall be large enough to enable the test subject wearing the suit to carry out various movements freely.

A.8 A sampling device located inside the chamber and connected by tubes to an aerosol detection device shall be used to sample the test atmosphere.

The device and methodology used shall be specified in the test report.

A.9 A sampling device located in the area of the helmet from which the test subject draws breath shall be used to sample the air in the test subject's breathing space.

The device and methodology used shall be specified in the test report.

A.10 The source of breathable air which supplies the connection located in the test chamber shall have a valve for adjusting the air flow rate and a calibrated flowmeter.

A.11 The procedures outlined in A.11.1 to A.11.10 shall be used for the aerosol test.

A.11.1 The test subject wearing the suit shall enter the chamber containing the test aerosol and shall connect his air supply pipe to the connection fixed inside the chamber and connected to the source of breathable air. The wearer shall then connect the sampling tube on the helmet to a nozzle located in the chamber and connected to the aerosol concentration-measuring apparatus. A background measurement shall be taken over a period of at least 2 min before the aerosol is introduced into the test chamber; at least 3 min shall elapse between the introduction of the aerosol into the test chamber and the start of the tests in order to allow the aerosol concentration to equalize.

A.11.2 The test subject shall perform the following set of exercises and the test operator shall make sure that the recorder connected to the aerosol-measuring apparatus records the leakage of aerosol into the helmet of the suit during each exercise. Each exercise shall be carried out for at least 120 s or, if no further increase in aerosol leakage is observed, for at least 30 s.

In the set of exercises, the test subject shall

a) keep perfectly still, with his arms at his side, and breathe normally;

b) bend forward and touch his toes, repeatedly;

c) run on the spot;

d) lift his arms above his head and look upwards, several times;

e) bend his knees and squat, repeatedly;

f) crawl on hands and knees;

g) stand with his arms folded in front of his chest and twist his torso from side to side repeatedly;

h) stand still, with his arms at his side, and breathe normally.

A.11.3 If any of the exercises outlined in A.11.2 give rise to high leakage (more than 1 %) of aerosol, the test shall be suspended.

A.11.4 Determine the average from the aerosol leakage values which occurred during each of the exercises (as described in A.11.2) carried out by the test subject. Record the mean leakage values.

Using the values determined above, calculate the mean leakage value for each of the exercises conducted by each test subject.

A.11.5 Repeat the procedure specified in A.11.2 to A.11.4, increasing air flow rates through the garment worn by the test subject by 1,5 m^3/h (25 l/min), from the minimum up to the maximum flow rate specified by the manufacturer.

A.11.6 Repeat the procedure specified in A.11.1 to A.11.5 for each test subject.

A.11.7 If the suit is of the re-usable type and if it, or part of it, can be washed, a washed suit or a suit, part of which has been washed, according to the procedures specified by the manufacturer, shall also be tested in accordance with the procedure specified in A.11.1 to A.11.6.

A.11.8 The ventilated-pressurized suit shall be approved as regards breathing and whole-body protection if the average aerosol leakage into the part of the garment from where the test subject draws breath does not exceed the values given in table 1 during any one of the exercises nor half of the values during the whole of the exercises for air flow rate through the garment, ranging from the minimum to the maximum values specified by the manufacturer.

Table 1

Class of ventilated-pressurized suits (see 4.1)	Maximum value of mean aerosol leakage into the helmet %		Minimum protection factor
	During one of the exercises	During all of the exercises	
I	0,01	0,005	20 000
II	0,02	0,01	10 000
III	0,1	0,05	2 000
IV	0,2	0,1	1 000

Annex B

Method for measuring leak-tightness of ventilated-pressurized garments

(This annex forms an integral part of the standard.)

B.1 Overpressure test (see figure 1)

B.1.1 General

A dummy having the same build as a wearer shall be placed in the garment. The outlet devices of the clothing shall be sealed by adequate means (stopper, adhesive tape, etc.). An adjustable source of air shall be sent into the garment through a rotameter and the pressure inside the garment shall be measured by means of a pressure gauge (manometer). The measuring systems shall be connected to the garment by a link piece, such as a cylindrical neck fixed in a sleeve with adhesive tape.

B.1.2 Principle

When the positive pressure in the garment has reached the selected test value [e.g. 150 Pa (1,5 mbar)], the power source shall be adjusted by a regulator so that the pressure does not change. The loss shown by the rotameter is equal to the loss due to leaks in the garment at the test pressure. The leaks are shown up by the formation of bubbles of a surface active liquid sprayed on the garment.

B.2 Negative pressure test (see figure 2)

The preparation of the garment shall be the same as that for the overpressure test but to prevent its collapse by atmospheric pressure, it is necessary to line the inside by one of the appropriate accessories (such as a metallic-frame dummy, plastic balls, etc.). The exhausted air passes through a rotameter and the pressure is indicated by a pressure gauge (manometer).

B.3 Requirement

The leak during the overpressure or negative pressure test shall be less than 0,12 m^3/h (2 l/min) for the test under 150 Pa (1,5 mbar).

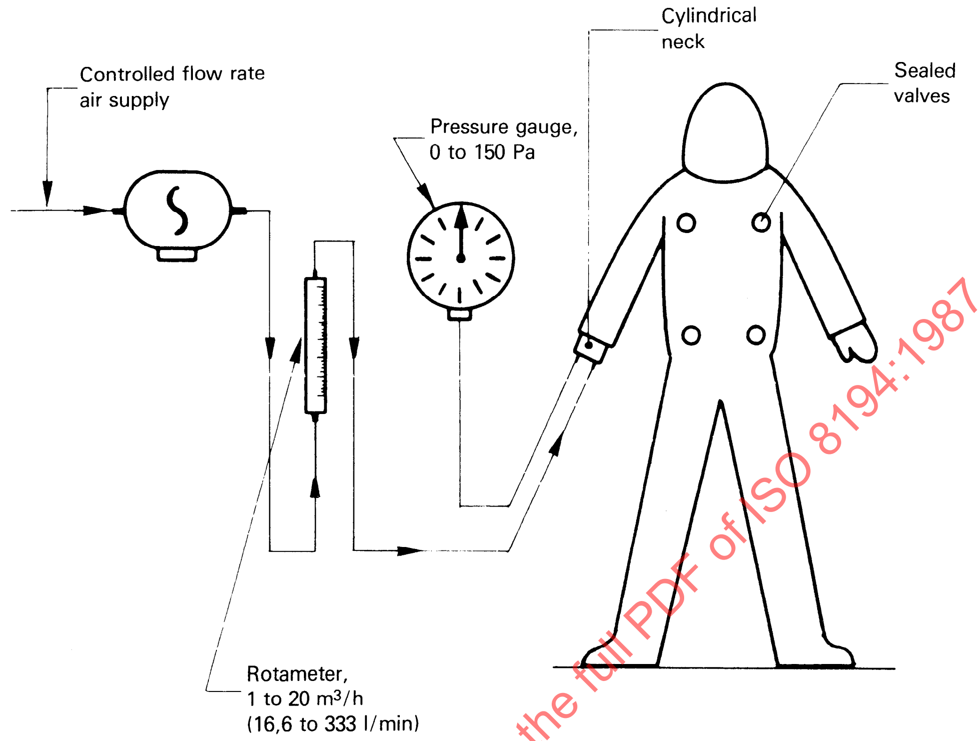

Figure 1 — Set-up and equipment for overpressure test (test with dummy)

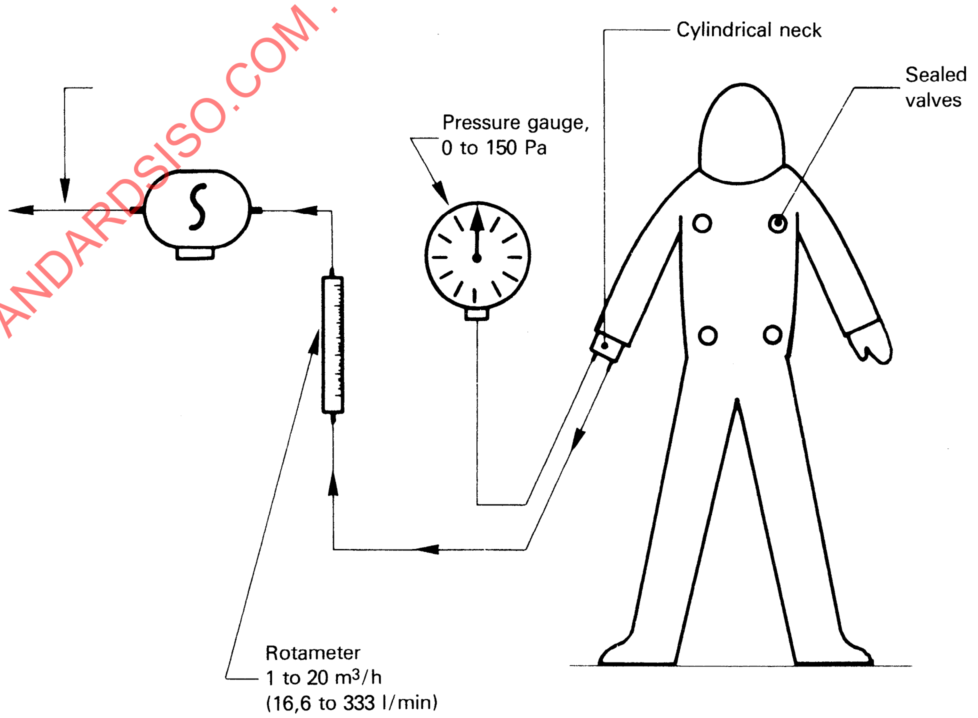

Figure 2 — Set-up and equipment for negative pressure test (test with dummy)

Annex C

Method for measuring air supply flow rate of ventilated-pressurized garments

(This annex forms an integral part of the standard.)

The air supply flow rate of a ventilated-pressurized garment depends upon the following factors:

a) the pressure of the source of air when flowing.

b) the loss in pressure in the supply tube, the regulating valve and the distributing tubes inside the garment.

The loss in pressure of the exhaust devices (in the order of a few hundred pascals or several millibars), which determines the positive pressure of the garment, is negligible in relation to the pressure of the compressed air (in the order of several kilopascals or bars).

This flow may be measured by means of a paddle flowmeter in which the measuring chamber is equipped with a pressure gauge (manometer), connected directly upstream to the garment. The actual flow which feeds the garment is equal to the measured flow, multiplied by the coefficient, C_p, given by the formula

$$C_p = \sqrt{\frac{p_r}{p_e}}$$

where

p_r is the actual absolute pressure, in pascals (or bars), in the chamber;

p_e is the standard absolute pressure, in pascals (or bars), of the flowmeter.

Figure 3 illustrates the test set-up needed for measuring the air supply flow rate.

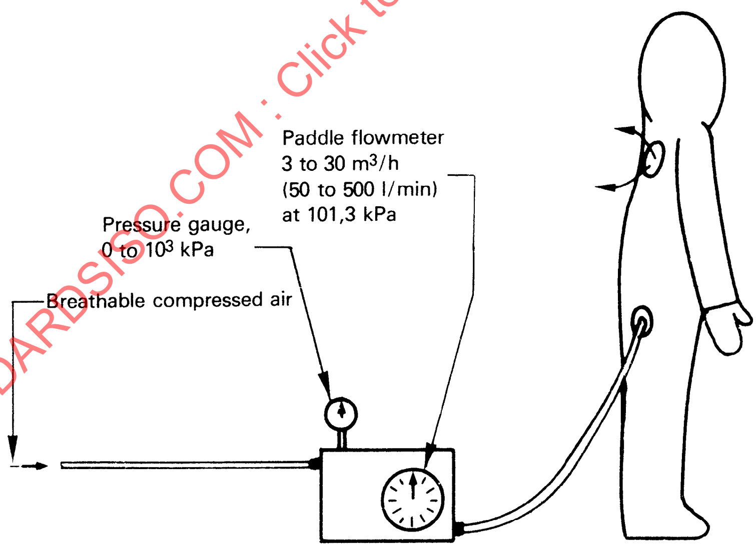

Figure 3 — Set-up and equipment for measuring the air supply flow rate

Annex D

Internal ventilation systems

(This annex does not form an integral part of the standard.)

D.1 Internal ventilation may be achieved by the fresh air supply situated at the extremities of the limbs (wrists and ankles) and/or at the top of the headgear with exhaust devices fixed close to the waist, and determined by centripetal ventilation. (See figure 4.)

D.2 Internal ventilation may be achieved by supplying fresh air to the top of the headgear, which then circulates to the extremities from where it is exhausted. (See figure 5.)

D.3 *Example:* the internal ventilation system may consist of the following component parts:

a) a rapid self-closing male coupling (fitted possibly with a protective cover against contamination) which is connected to the source of compressed, breathable air at medium pressure [2×10^2 to 10^3 kPa (2 to 10 bar)];

b) a flexible pipe made from reinforced plastics, with an internal diameter of 5 to 10 mm, depending on the nominal pressure [2×10^2 to 10^3 kPa (2 to 10 bar)], designed to withstand a test pressure of 2×10^3 kPa (20 bar), which feeds compressed air to the valve on the garment;

c) a regulating valve fixed to the garment, communicating with a distribution box working in several directions, on the ends of which are attached some flexible plastic tubes, four of which, for instance, go to the limbs and one to the helmet.

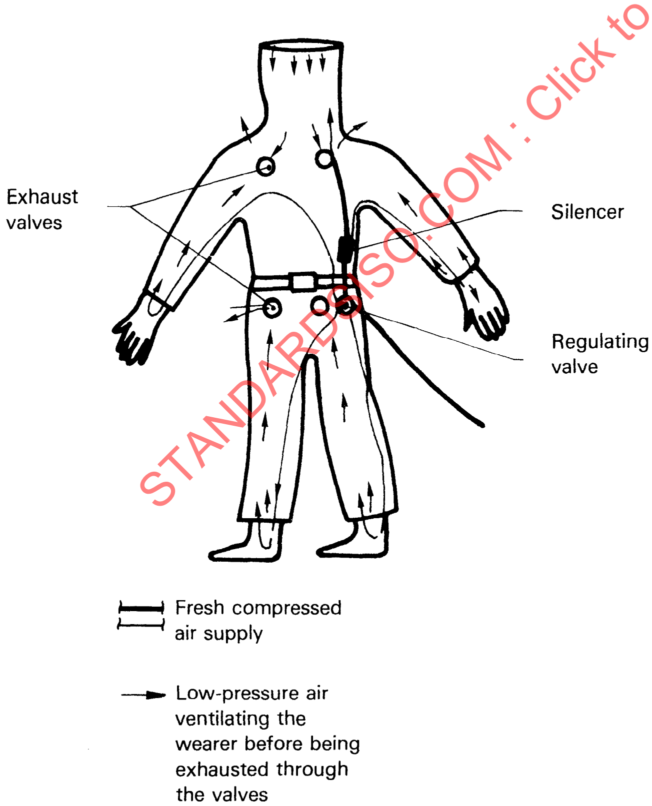

Figure 4 — Internal ventilation device with the fresh air supply situated at the extremities of the limbs and at the top of the headgear, the air being exhausted through valves

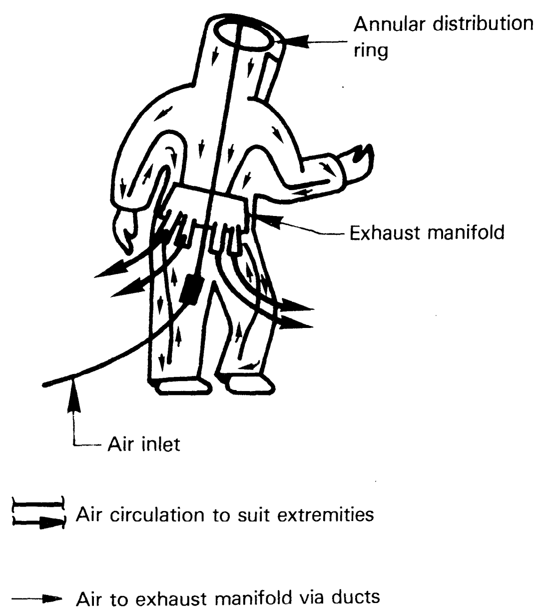

Figure 5 — Internal ventilation device supplying fresh air to the top of the headgear, the air being extracted from the extremities of the limbs and exhausted through a manifold

Annex E

Exhaust devices

(This annex does not form an integral part of the standard.)

The main exhaust devices may consist of the following parts:

a) outlet valves on filtering respiratory devices, with or without adjusted flaps, with or without channelled outlets;

b) leaf valves consisting of two plastic leaves held by a spring; air passes between the surface pushing them aside;

c) simple openings, with channelled outlet;

d) high efficiency filters;

e) a venturi tube which sucks up the air from the garment and releases it into a pipe passing into the air intake pipe.

In the absence of an exhaust device, the air leaves freely to the surrounding atmosphere.