BRITISH STANDARD

BS 8428:2004
Incorporating Corrigendum No. 1

Protective clothing —

Protection against liquid chemicals —

Performance requirements for chemical protective suits with liquid-tight connections between different parts of the clothing for emergency teams (type 3-ET equipment)

ICS 13.340.10

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee PH/3, Protective clothing, to Subcommittee PH/3/3, Clothing for protection against chemicals, upon which the following bodies were represented:

British Clothing Industry Association

British Safety Industry Federation Test and Certification Association

Chief and Assistant Chief Fire Officers Association

Chemical Industries Association

Fire Brigades Union

Health and Safety Executive

Institute of Occupational Medicine

Institution of Occupational Safety and Health

London Fire and Emergency Planning Authority

NHS Purchasing and Supply Agency

Office of the Deputy Prime Minister (Her Majesty's Fire Services Inspectorate)

Personal Safety Manufacturers Association

SATRA Technology Centre

Textile Services Association Limited

Co-opted members

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15007 Corrigendum No. 1	9 February 2004	Correction to title on front cover

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Committee reference PH/3/3
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Contents

Foreword

This British Standard has been prepared by Subcommittee PH/3/3.

This British Standard is to be used in conjunction with BS EN 943 which specifies requirements for protective clothing against liquid and gaseous chemicals.

This British Standard is also to be used in conjunction with BS 7184 which gives guidance on the use and maintenance of chemical protective clothing.

NOTE BS 7184 references prEN 466-2 as specifying requirements for liquid-tight chemical protective suits for emergency teams. However, prEN 466-2 is no longer being developed for publication as a European Standard and so reference should be made to this British Standard, BS 8428, instead.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 9 and a back cover.

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1 Scope

This standard specifies performance requirements for chemical protective suits with liquid-tight connections between different parts of the clothing for use by emergency teams, e.g. fire brigades, in situations where the chemical hazards are not immediately identifiable.

This standard specifies performance requirements for both the materials of construction of the chemical protective suit and for the suit as a whole, including component parts, seams, joins and assemblages.

This standard is applicable to reusable and limited-use chemical protective suits.

Chemical protective clothing conforming to this standard is not designed to provide protection against gases and vapours. Performance requirements for gas-tight chemical protective suits for emergency teams are given in BS EN 943-2.

NOTE Suits conforming to this standard can be suitable for use in situations other than those involving purely chemicals, e.g. situations involving infective agents and radioactive contamination. Information supplied by suit manufacturers can indicate such additional performance applications.

The chemical protection suits specified in this standard are designed to be used with respiratory protective devices. However, this standard does not specify requirements for respiratory protective devices.

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.

BS EN 340*, Protective clothing — General requirements.*

BS EN 345-2:1997*, Safety footwear for professional use — Part 2: Additional specifications.*

BS EN 374-1*, Protective gloves against chemicals and micro-organisms —Part 1: Terminology and performance requirements.*

BS EN 463*, Protective clothing — Protection against liquid chemicals — Test method: Determination of resistance to penetration by a jet of liquid (Jet test).*

BS EN 943-1:2002*, Protective clothing against liquid and gaseous chemicals, including liquid aerosols and solid particles — Part 1: Performance requirements for ventilated and non-ventilated "gas-tight" (Type 1) and "non-gas-tight" chemical protective suits.*

BS EN 943-2:2002*, Protective clothing against liquid and gaseous chemicals, including liquid aerosols and solid particles — Part 2: Performance requirements for "gas-tight" (Type 1) chemical protective suits for emergency teams (ET).*

PD CEN ISO/TR 11610, *Protective clothing — Glossary of terms and conditions.*[1)]

3 Terms and definitions

For the purposes of this British Standard, the terms and definitions given in PD CEN ISO/TR 11610[1)], BS EN 943-2 and the following apply.

3.1
type 3-ET suit
liquid tight chemical protective suit for use by emergency teams (ET)

3.2
type 3a-ET suit
type 3-ET suit with a breathable air supply independent of the ambient atmosphere and worn inside the suit

NOTE For example, when a self-contained open-circuit compressed air breathing apparatus is worn inside a type 3-ET suit, it is considered a type 3a-ET suit.

[1)] In preparation.

3.3
type 3b-ET suit
type 3-ET suit with a breathable air supply worn outside the suit

NOTE For example, when a self-contained open circuit compressed air breathing apparatus is worn outside a type 3-ET suit, it is considered a type 3b-ET suit.

3.4
bootee
sock-like extension of the chemical protective suit leg that covers the entire foot

NOTE A bootee can be internal or external to any footwear worn.

3.5
exhaust assembly
device that enables exhaled air to be vented from a chemical protective suit to the atmosphere to prevent over-pressure within the suit

NOTE An exhaust assembly can consist of one or more exhalation valves.

3.6
personal line
length of cord fitted to breathing apparatus sets or chemical protective suits with the purpose of preventing team members from getting separated from each other or lost in conditions of limited visibility

NOTE For example, the line can be used to join one or more team members together or to join several team members to a fixed guide line.

4 Materials

4.1 General

Materials used in the construction of type 3-ET suits shall not be known to cause skin irritation or have any adverse effect to health.

NOTE The materials used in the construction of type 3-ET suits should be as light and as flexible as possible in order to ensure wearer comfort as well as providing effective protection.

4.2 Mechanical properties

Following pre-conditioning and conditioning in accordance with BS EN 943-1:2002, **B.2.1** and **B.2.2**, type 3-ET suit material shall be tested and classified in accordance with BS EN 943-1 for the mechanical properties specified in Table 1.

NOTE 1 Limited-use type 3-ET suits are not intended to be used repeatedly, therefore the performance classes specified in Table 1 to demonstrate the durability of limited-use type 3-ET suit material are in some instances different to those specified for type 3-ET suit material intended for repeated use.

NOTE 2 If only class 2 is achieved for puncture resistance, the type 3-ET suit can be unsuitable for use where there is a high risk of puncture.

Table 1 — Performance classes for chemical protective suit materials

Property	BS EN 943-1:2002 subclause that specifies the test	Performance class as defined in BS EN 943-1:2002	
		Limited-use suits	Reusable suits
Abrasion resistance	**B.2.3**	Class 4	Class 6
Flex cracking resistance	**B.2.4**	Class 1	Class 4
Flex cracking resistance at low temperatures (–30 °C)	**B.2.5**	Class 2	Class 2
Trapezoidal tear resistance	**B.2.6**	Class 3	Class 3
Tensile Strength	**B.2.8**	Class 4	Class 6
Puncture resistance	**B.2.9**	Class 2	Class 3
Resistance to flame	**B.2.14**	Class 1	Class 3

4.3 Chemical permeation

Following pre-conditioning and conditioning in accordance with BS EN 943-1:2002, **B.2.1** and **B.2.2**, the chemical permeation resistance of type 3-ET suit material shall be tested and classified in accordance with BS EN 943-1:2002, **B.2.10** for each of the liquid and gaseous standard test chemicals specified in Table 2.

If the type 3-ET suit material only achieves class 2 or lower after testing with a chemical in accordance with BS EN 943-1:2002, **B.2.10**, the chemical suit material shall be unsuitable for use with this chemical under continuous exposure.

NOTE 1 The list of permeation test chemicals specified in Table 2 is not inclusive of all the chemicals for which the type 3-ET suit may be used.

NOTE 2 The standard test chemicals in Table 2 are representative of a number of different groups of chemicals regardless of their physical state (i.e. their generic representation). However, acceptable permeation performance of a type 3-ET suit material against chemicals, other than those listed, in no way implies that the design of a type 3-ET suit is adequate protection against that chemical. Such a chemical should be tested and classified on an individual basis in accordance with BS EN 943-1:2002, **B.2.10**.

NOTE 3 Despite obtaining favourable permeation performance results, exposure of the type 3-ET suit material to a given chemical or chemicals can result in significant chemical permeation into that material. After operational use, the user should ascertain whether permeation has occurred and, if so, whether such permeation either presents a hazard to subsequent wearers or compromises the future level of protection afforded by the material.

Table 2 — Test chemicals for permeation tests and their generic representation

Test chemical	Physical state	Generic representation
Dichloromethane	Liquid	Chlorinated hydrocarbon
Methanol	Liquid	Primary alcohol
n-Heptane	Liquid	Saturated hydrocarbon
Toluene	Liquid	Aromatic hydrocarbon
Diethylamine	Liquid	Amine
Sodium hydroxide 40 %	Liquid	Inorganic base
Sulfuric acid 96 %	Liquid	Inorganic mineral acid
Ammonia	Gas	Basic gas
Chlorine	Gas	Halogen gas
Hydrogen chloride	Gas	Inorganic gas
Acetone	Liquid	Ketone
Acetonitrile	Liquid	Nitrile compound
Ethyl acetate	Liquid	Ester
Carbon disulfide	Liquid	Sulfur containing organic compound
Tetrahydrofuran	Liquid	Heterocyclic and ether compound

5 Suit components

5.1 General

Following pre-conditioning and conditioning in accordance with BS EN 943-1:2002, **B.2.1** and **B.2.2**, the type 3-ET suit components specified in **5.2** to **5.7** shall be tested and classified for resistance to chemical permeation in accordance with **4.3**.

For safety footwear, the test specimen for chemical permeation testing shall be taken from the thinnest point of the footwear above the join to the sole.

5.2 Protective gloves

Permanently fitted or detachable protective gloves shall conform to BS EN 374-1.

NOTE As BS EN 374-1 specifies only very limited mechanical and thermal requirements for protective gloves, an over-glove, e.g. conforming to BS EN 659, can be used to provide greater mechanical and thermal protection.

5.3 Safety footwear

Permanently fitted or detachable safety footwear, including external bootee supplied by the manufacturer shall conform to safety footwear type FPA as specified in BS EN 345-2:1997, Clause **7**.

An integral sock or integral bootee shall provide at least the same level of protection as the material from which the type 3-ET suit is manufactured, i.e. as a minimum the integral sock or integral bootee shall conform to Clause **4**.

5.4 Visor

Where a visor is fitted as part of the type 3-ET suit, it shall conform to BS EN 943-1:2002, **5.5**.

NOTE A visor is not the same as a facemask integral to, attached permanently to or detachable from a type 3-ET suit.

If there is any visual indication of the visor distorting vision after being tested in accordance with **4.3**, the visor shall be tested in accordance with BS EN 943-2:2002, **8.2**. The visor shall not distort vision when exposed to each of the chemicals listed in Table 2.

5.5 Facemask

Where a facemask is integral to, attached permanently to or detachable from the type 3-ET suit, it shall conform to BS EN 943-1:2002, **5.6**.

5.6 Exhaust assembly

A type 3a-ET suit shall be fitted with an exhaust assembly.

A type 3b-ET suit shall be fitted with an exhaust assembly if the exhalation valve of the respiratory protective equipment is not free to discharge directly into the atmosphere, or where supplementary air for ventilation is supplied to the chemical protection suit.

NOTE The exhaust assembly fitted to a type 3-ET suit may consist of one or more exhaust valves.

5.7 Pass-through for use with self-contained breathing apparatus

Where a pass-through is fitted as part of the type 3-ET suit, it shall conform to BS EN 943-1:2002, **5.7**.

NOTE As type 3-ET suits are intended for use in emergency situations, the inclusion of a pass-through should be considered on type 3a-ET suits. This is to ensure that a breathable air supply is maintained should a lengthy period of decontamination be necessary following exposure to hazardous chemicals.

6 Seams, joins and assemblages

6.1 General

The type 3-ET suit shall be tested as a whole, including component parts such as gloves or boots that are integral to the suit, when tested in accordance with **6.2** to **6.6**.

6.2 Resistance of closures or closure assemblies to chemical permeation

Following pre-conditioning and conditioning in accordance with BS EN 943-1:2002, **B.3.2** and **B.3.3**, the type 3-ET suit closures or closure assemblies shall be tested and classified for resistance to chemical permeation in accordance with **4.3**.

The breakthrough time shall be at least 5 min for each chemical specified in Table 2. If a breakthrough time of between 5 min and 10 min is achieved after testing in accordance with **4.3**, the value shall be recorded.

NOTE 1 A value, rather than a class, is recorded for a breakthrough time of between 5 min and 10 min, because the BS EN 943-1 chemical permeation test method specified in **4.3** does not define a class for breakthrough times in this range.

NOTE 2 The test cell used in the chemical permeation tests specified in **4.3** should be modified for the testing of closures in order to ensure that the sample can be fitted correctly into the cell.

If the closure or closure assembly does not conform to the class 2 chemical permeation classification specified in **4.3**, or cannot be tested, the closure or closure assembly shall be protected by a flap or cover that conforms to class 2 to reduce the risk of liquid chemical contact.

6.3 Resistance of seams to chemical permeation

Following pre-conditioning and conditioning in accordance with BS EN 943-1:2002, **B.3.2** and **B.3.3**, the type 3-ET seams shall be tested and classified for resistance to chemical permeation in accordance with **4.3**.

NOTE The test cell used in the chemical permeation tests specified in **4.3** should be modified for the testing of seams in order to ensure that the sample can be fitted correctly into the cell.

If, for a particular chemical, a seam conforms to the class 1 chemical permeation classification specified in **4.3**, the chemical protective suit shall be unsuitable for use against this chemical under continuous exposure.

6.4 Seam strength

Following pre-conditioning and conditioning in accordance with BS EN 943-1:2002, **B.3.2** and **B.3.3**, the type 3-ET suit seam strength shall conform to class 5 when tested in accordance with BS EN 943-1:2002, **B.3.5**.

6.5 Attachment points

Where an attachment point for a personal line is fitted as part of the type 3-ET suit, it shall be tested in accordance with BS EN 943-1:2002, **5.7.1** and shall withstand a pulling force of at least 1 000 N. The attachment point shall not separate from the suit and the suit shall remain intact.

The attachment point for any other items of equipment shall be tested in accordance with BS EN 943-1:2002, **5.7.1** and shall withstand a pulling force of at least 250 N. The attachment point shall not separate from the suit and the suit shall remain intact.

6.6 Connection between exhalation valve (exhaust assembly) and suit material

If exhalation valves are fitted as part of the type 3-ET suit, the connection between the valves and the chemical protective suit shall be tested in accordance with BS EN 943-1:2002, **6.5** and shall withstand a pulling force of at least 150 N. The connection shall not separate from the suit and the suit shall remain intact.

7 The whole suit

7.1 General

The type 3-ET suit shall be constructed so that the wearer has freedom of movement and is as comfortable as possible, consistent with the protection afforded by the chemical protective suit.

The outside of the type 3-ET suit shall be without pockets or features similar to pockets.

The outside of the type 3-ET suit shall have areas for placing identification marks.

A type 3a-ET suit shall allow for the use of compressed air breathing apparatus and a head protection device, e.g. a fire helmet, inside the suit.

A type 3a-ET suit shall provide a reinforcement in the back part (hump) of the suit to protect the type 3a-ET suit against mechanical damage from compressed air breathing apparatus.

All type 3-ET suits shall be tested in accordance with **7.3** and **7.4**.

7.2 Preparing a type 3-ET suit for testing

All type 3-ET suits, when tested in accordance with **7.3** and **7.4**, shall be worn in their working configuration, i.e. with all their component parts.

A type 3a-ET suit, when tested in accordance with **7.3** and **7.4**, shall have either a visor conforming to **5.4** or a facemask conforming to **5.5**.

A type 3b-ET suit, when tested in accordance with **7.3** and **7.4**, shall have either an integral or permanently attached facemask conforming to **5.5**.

7.3 Resistance to penetration by liquids (jet test)

Three type 3-ET suits shall be prepared in accordance with **7.2** and tested in accordance with BS EN 463. There shall be no penetration of any of the three suits. For the purposes of this standard, suit penetration shall be considered as having occurred when the total stain area on the undergarment is greater than three times the total calibrated stain area.

NOTE The calibration of the stain area is described in BS EN 463.

7.4 Practical performance test

The type 3-ET suit shall be prepared in accordance with **7.2** and tested in accordance with the practical performance test in BS EN 943-2:2002, **8.1**.

The clothing worn under the type 3-ET suit for the practical performance tests shall be included as part of the information supplied by the manufacturer (see Clause **9**).

8 Marking

The type 3-ET suit shall be marked with at least the following information.

a) The name, trade mark or other means of identification of the manufacturer.

b) The type of chemical protective suit, i.e. type 3a-ET (limited-use), type 3a-ET (reusable), type 3b-ET (limited-use) or type 3b-ET (reusable).

c) The number and date of this standard, i.e. BS 8428:2004.

d) The year and month of manufacture of the suit.

e) The manufacturer's type number, identification number or model number.

f) The size range as defined in BS EN 340.

g) The pictogram specified in BS EN 943-1:2002, Figure 2 showing that the suit is for protection against chemicals.

h) The pictogram specified in BS EN 943-1:2002, Figure 2 showing that the manufacturer's instructions should be read.

NOTE Consideration should be given to suitable additional marking.

The marking shall be clearly visible and as durable as necessary for the life of the clothing.

9 Information supplied by the manufacturer

Information shall accompany every type 3-ET suit and shall contain at least the following.

a) The name, trademark or other means of identification of the manufacturer and/or his authorized representative.

b) The manufacturer's type number, identification number or model number.

c) The size range as defined in BS EN 340.

d) The performance achieved by the type 3-ET suit material for the mechanical properties specified in **4.2**. Note that when only class 2 has been achieved for puncture resistance after testing in accordance with **4.2**, a statement shall be included that warns the user that the chemical protective clothing may not be suitable for use where there is a high risk of puncture.

e) The chemical permeation performance classes achieved in accordance with **4.3** for each of the chemicals listed in Table 2 for each of the following items 1) to 4), stating the names of the chemicals and chemical products (including the names and approximate concentrations of the components) to which these items have been tested or a reference to where this information can be obtained (e.g. manufacturer's telephone/fax number).

1) Type 3-ET suit material specified in **4.3**. Note that when only class 2 or lower is achieved for any of the test chemicals listed in Table 2, after testing for resistance to chemical permeation in accordance with **4.3**, a statement shall be included that warns the user that the type 3-ET suit is unsuitable for use for this chemical under continuous exposure.

2) Suit components specified in Clause **5**, where fitted.

3) Closures and closure assemblies specified in **6.2**.

4) Seams specified in **6.3**. Note that when a seam is only rated class 1 for any of the test chemicals listed in Table 2, after testing for resistance to chemical permeation in accordance with **4.3**, a statement shall be included that warns the user that the type 3-ET suit is unsuitable for use against this chemical under continuous exposure.

f) The performance achieved for:

1) the seam strength of the type 3-ET suit, as specified in **6.4**;

2) the attachment points of the type 3-ET suit, as specified in **6.5**;

3) the connection between exhalation valve (exhaust assembly) and the type 3-ET suit material, as specified in **6.6**;

4) the resistance of the type 3-ET suit to penetration by liquids, as specified in **7.3**.

g) Results of practical performance tests specified in **7.4**, including a note about what clothing was worn under the type 3-ET suit during testing.

h) All other test performance levels achieved for properties that are not required to be specified by this standard but are seen as useful by the manufacturer, preferably in a table of performance.

i) The expected shelf-life of the chemical protective suit.

j) Information necessary for trained persons on:

1) application and limitations of use (temperature range, breathing air supply, etc.);

2) tests to be carried out by the wearer before use (if required);

3) fitting;

4) use;

5) maintenance and cleaning (including, for example, guidance for decontamination and disinfecting);

6) storage.

k) A statement that compliance with this standard does not infer compliance with standards relating to other hazards, e.g. heat and flame standards.

NOTE If helpful, part numbers for each of the type 3-ET suit items, illustrations, and marking, etc. should be included as part of the information supplied by the manufacturer.

Information supplied by the manufacturer shall be unambiguous.

Warnings shall be given against problems likely to be encountered.

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Bibliography

BS EN 659, *Protective gloves for firefighters.*

9 February 2004

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