British Standard

BRITISH STANDARD

BS 6906-7: 1990

Methods of test for

Geotextiles —

Part 7: Determination of in-plane waterflow

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Textiles and Clothing Standards Policy Committee (TCM/-) to Technical Committee TCM/35, upon which the following bodies were represented:

Association of Consulting Engineers
British Polyolefin Textiles Association
British Textile Technology Group
Chemical Industries Association
Department of Transport
Department of Transport (Transport and Road Research Laboratory)
ERA Technology Ltd.
Federation of Civil Engineering Contractors
Institution of Civil Engineers
Lambeg Industrial Research Association
Ministry of Agriculture, Fisheries and Food
Ministry of Defence
Society of Engineers Incorporated

This British Standard, having been prepared under the direction of the Textiles and Clothing Standards Policy Committee, was published under the authority of the Board of BSI and comes into effect on 31 December 1990

The following BSI references relate to the work on this standard:
Committee reference TCM/35
Draft for comment 89/39362 DC

ISBN 0 580 18702 0

Amendments issued since publication

Amd. No.	Date	Comments

Contents

Foreword

This Part of BS 6906 has been prepared under the direction of the Textiles and Clothing Standards Policy Committee.

This standard describes a method for determination of water flow through the plane of the geotextile under specified normal compressive stress and hydraulic gradient and is an additional method to that described in BS 6906-3 which determines water flow normal to the plane of the geotextile.

Other Parts of BS 6906 are as follows.

— *Part 1: Determination of the tensile properties using a wide width strip;*

— *Part 2: Determination of the apparent pore size distribution by dry sieving;*

— *Part 3: Determination of water flow normal to the plane of the geotextile under a constant head;*

— *Part 4: Determination of the puncture resistance (CBR puncture test);*

— *Part 5*[1)]*: Determination of creep;*

— *Part 6: Determination of resistance to perforation (cone drop test);*

— *Part 8*[1)]*: Method for investigating sand-geotextile frictional behaviour by direct shear.*

Information on the accuracy of the test is given in Appendix A.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their 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 8, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

[1)] In preparation.

1 Scope

This Part of BS 6906 describes an index test procedure for determining the constant head water flow within the manufactured plane of geotextiles and related products under varying compressive stresses and typical hydraulic gradients.
The method can be adapted to model particular field conditions, e.g. by employing other contact surfaces, stresses and hydraulic gradients.

The procedure is limited to geotextiles and related materials that allow continuous flow paths to develop parallel to the longest edge of the specimen tested.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this Part of BS 6906 the following definitions apply.

2.1
normal stress

the stress component (in kPa) normal to a given plane

2.2
hydraulic transmissivity

the volumetric flow rate of water per unit width of specimen per unit gradient in a direction parallel to the plane of the specimen

2.3
in-plane flow

fluid flow confined to a direction parallel to the plane of the geotextile

2.4
gravity flow

flow in a direction parallel to the plane of the geotextile driven predominantly by a difference in elevation between the inlet and outlet points of a specimen

2.5
pressure flow

flow in a direction parallel to the plane of the geotextile driven predominantly by a differential fluid pressure

2.6
hydraulic gradient

ratio of the length of specimen in the flow direction to the total head loss across the specimen

3 Principle

The in-plane water flow is determined by measuring the quantity of water that passes along the test specimen in a known time and under specified normal stress and hydraulic gradient.

4 Apparatus

4.1 *Constant head in-plane water flow apparatus*, (typical unit illustrated in Figure 1). The loading platen shall be a very good fit, and shall not leak. There shall be provision for maintaining a constant water level at several different water levels to correspond to, at least, hydraulic gradients of 0.1 and 1.0. The apparatus shall be substantially leak free when the platen is seated in the unit without the test specimen.

4.2 *Loading mechanism*, capable of sustaining a constant normal stress on the specimen ranging from 10 kPa to at least 250 kPa.

4.3 *Device such as a dial gauge*, to measure changes in specimen thickness during the test (when this is specified).

NOTE For details of the source of supply of a suitable apparatus apply to Enquiries Section, BSI, Linford Wood, Milton Keynes, MK14 6LE, enclosing a stamped, addressed envelope for reply.

5 Test specimens

5.1 Selection of test specimens

Take specimens at random from the sample. Unless otherwise agreed between the interested parties, take specimens no nearer than 100 mm from the selvedge of the geotextile.

5.2 Number and dimensions of test specimens

Unless otherwise agreed between the interested parties, cut three test specimens from the sample with the length parallel to the machine direction, and three specimens with the length parallel to the cross direction. The specimens shall be clean and dry, and measure 300 mm in the length or flow direction and 200 mm in the width direction.

NOTE It is important that the specimen width is not undersize, i.e. a good push tight fit.
Where it is necessary to determine results to within a given confidence interval of the mean, determine the number of test specimens in accordance with BS 2846-2.

6 Procedure

6.1 Contact surface

The surfaces contacting the specimens shall be one of the following.

a) the hard base of the apparatus and the lower rigid surface of the loading platen;

b) other materials such as closed cell foam rubber or soil used to model field situations.

NOTE 1 Option b) should be by agreement between the interested parties and should be reported under item c) of the test report (see clause **8**).

NOTE 2 The nature of the material in contact with the geotextiles in the field may be modelled using this test method. A rigid platen on one or both sides of the specimen simulates like surfaces encountered in the field (e.g. concrete walls, stiff geomembranes, etc.) where intrusion into the geotextile pore space is not anticipated. Where pore intrusion is expected, as is the case when the geotextile is in contact with soil, a closed-cell foam rubber layer (no continuous flow paths) may be placed between the platen and the geotextile specimen.

6.2 Hydraulic gradient

Perform the test using hydraulic gradients of 0.1 and 1.0.

NOTE Other hydraulic gradients may be selected, by agreement between the interested parties, which are more appropriate for the end use of the material and for the specific field conditions. This should be reported under item f) of the test report (see clause **8**).

6.3 Applied normal stress

Apply normal stress values of 25,100 and 250 kPa.

NOTE Other stress values may be employed, by agreement between the interested parties, to simulate specific field situations. This should be reported under item f) of the test report (see clause **8**).

6.4 Test method

6.4.1 Place the lower contact surface material or substratum (if required) on the base and then place the test specimen on top of the substratum ensuring that all wrinkles, folds, etc. are removed. Place the upper contact surface material or superstratum (if required) over the specimen in a similar manner. Lower the loading platen on to the test specimen (and model contact surfaces, if present).

6.4.2 Place a small seating stress of 2 kPa on the specimen and fill the reservoir with water to allow water to flow through the test specimen. Visually check for preferential flow paths along the boundaries of the test specimen. If such flows are observed, re-seat or discard the test specimen as required.

6.4.3 Seat the specimen under the lowest normal stress to be used (usually 25 kPa). Record the change in specimen thickness (if required).

NOTE Thickness measurement is not applicable if model contact surfaces are employed.

6.4.4 Fill the reservoir to the level corresponding to the lowest hydraulic gradient to be used (usually 0.1). Use water from a still tank for flow values less than 0.2 L/s.

NOTE For practical reasons, water direct from the mains supply may be used for water flows greater than 0.2 L/s.

6.4.5 Allow water to flow through the specimen under these conditions for a minimum of 10 min or until steady uniform flow has been achieved.

NOTE For some materials, especially those exhibiting compression creep, the stress may tend to decay during the test if, say, a hydraulic jack is employed to apply the stress. In this case, continual re-adjustment of the stress will be necessary to maintain a constant value during the test period.

6.4.6 Collect a sample of water flowing over the outlet weir for a known time period. The volume of this sample shall be not less than 0.5 L or for very high flow materials the period shall be not less than 5 s. Record the volume collected and note the water temperature. Repeat this procedure two more times, i.e. three flow readings in all.

6.4.7 Increase the hydraulic gradient to the next highest to be used (usually 1.0) whilst maintaining the stress value. Repeat **6.4.6**.

6.4.8 Repeat **6.4.7** for any and all higher hydraulic gradients.

6.4.9 Increase the normal stress to the next highest value (usually 100 kPa). Repeat **6.4.4** to **6.4.7**.

6.4.10 Continue increasing the stress and repeating **6.4.4** to **6.4.7** until readings at the highest stress value to be used have been taken.

6.4.11 Repeat the whole sequence of operations **6.4.1** to **6.4.10** for the remaining test specimens.

7 Calculations

7.1 Calculate the hydraulic transmissivity, if required, using the following equation:

$$\theta = (QL)/(WH)$$

where

θ is the hydraulic transmittivity (in m^2/s);

Q is the average quantity of fluid discharged per unit time (in m^3/s);

L is the length of the specimen (in m);

W is the width of the specimen (in m);

H is the difference in total head across the specimen (in m).

NOTE If the hydraulic transmissivity calculated in this test method is to be used to determine the coefficient of in-plane permeability of the specimen, the test should be conducted under laminar flow conditions. The constant head technique may be used as a check to determine if laminar or turbulent flow conditions exist. To determine the flow regime under specific test conditions, plot the flow rate per unit width of the specimen versus the hydraulic gradient under each of the applied normal stresses. The data points for tests performed under each normal stress form a straight line passing through the origin if the test was conducted under laminar flow conditions. A non-linear response suggests that turbulent flow conditions exist and Darcy's law (i.e. the flow rate is linearly proportional to the hydraulic gradient under laminar flow conditions) is not considered valid.

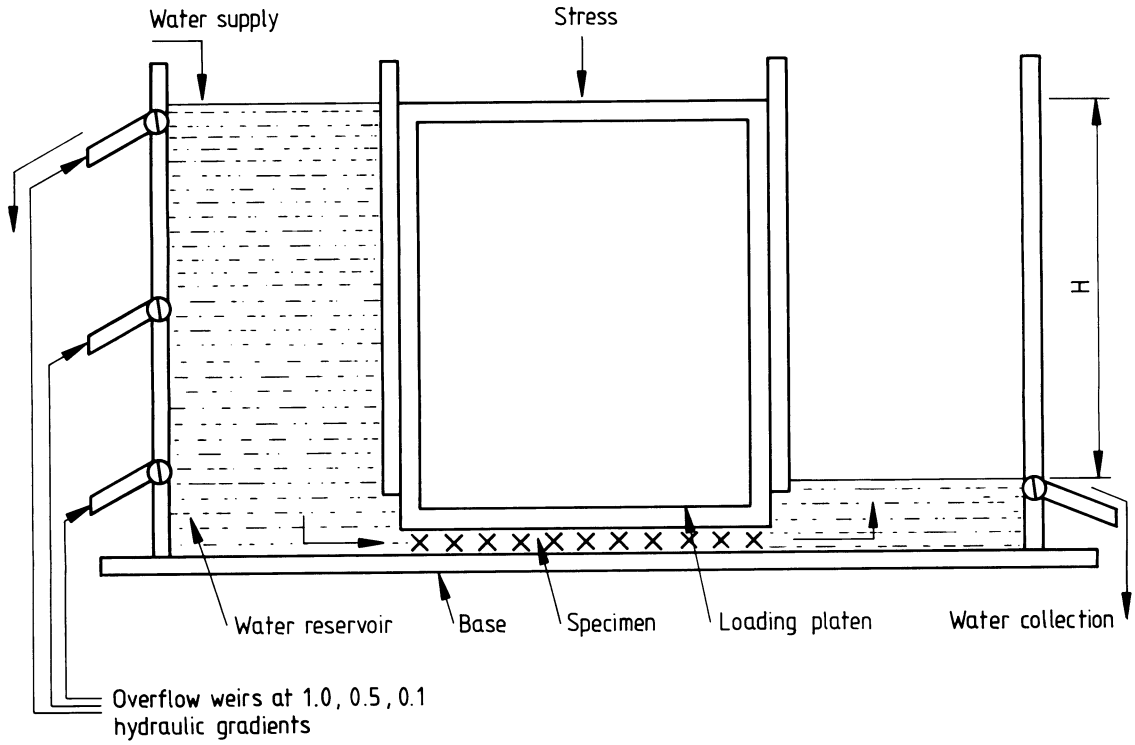

Figure 1 — Constant head in-plane water flow apparatus (example of typical arrangement)

7.2 Correct the hydraulic transmissivity to that for 20 °C by multiplying the hydraulic transmissivity by the ratio of the viscosity of water at test temperature to the viscosity of water at 20 °C (see Figure 2).

7.3 Results can be expressed in one of the following ways:

a) as a plot of hydraulic transmissivity versus hydraulic gradient (see Figure 3);

b) as a plot of hydraulic transmissivity versus normal compressive stress (see Figure 4);

c) as a plot of flow rate per unit width versus normal compressive stress (see Figure 5).

8 Test report

The test report shall include the following particulars:

a) the number and date of this British Standard, i.e. BS 6906-7:1990;

b) full identification details of the sample tested;

c) the contact surfaces employed;

d) the flow values expressed either as flow per unit width (in $m^3\ s^{-1}\ m^{-1}$) or as hydraulic transmissivity (in $m^2\ s^{-1}$) at each hydraulic gradient and normal stress condition employed. Mean, standard deviation and coefficient of variation of temperature corrected flow values for the test specimens in each material direction shall be reported;

e) all details of differences from the procedures, e.g. contact surfaces, hydraulic gradient and normal stress;

f) the temperature of the water (in °C);

g) the thickness measurements (if required);

The test report may also include the following particulars

h) graphical representation of data (if required) as shown in Figure 3, Figure 4 and Figure 5.

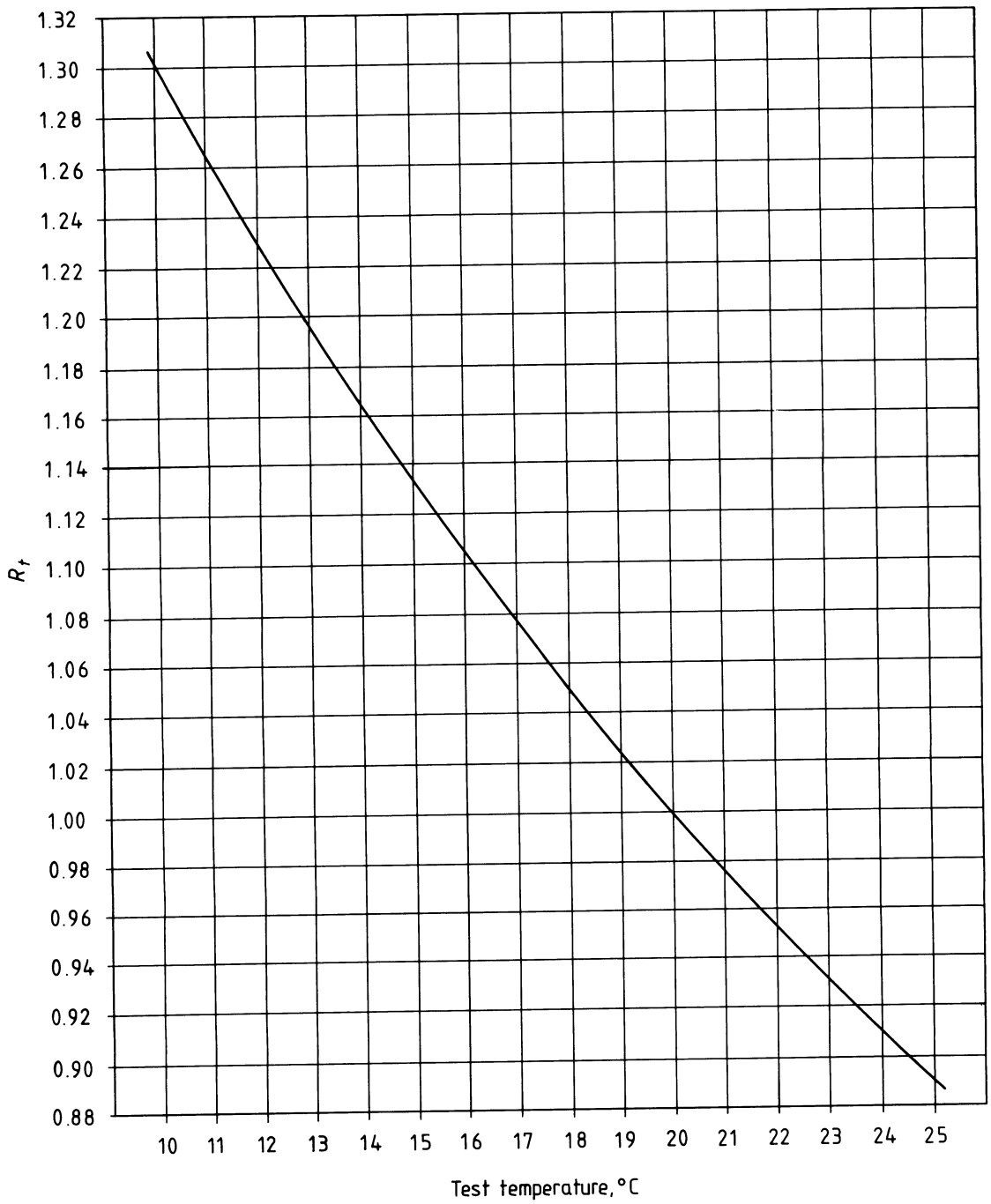

Figure 2 — Water viscosity correction factor

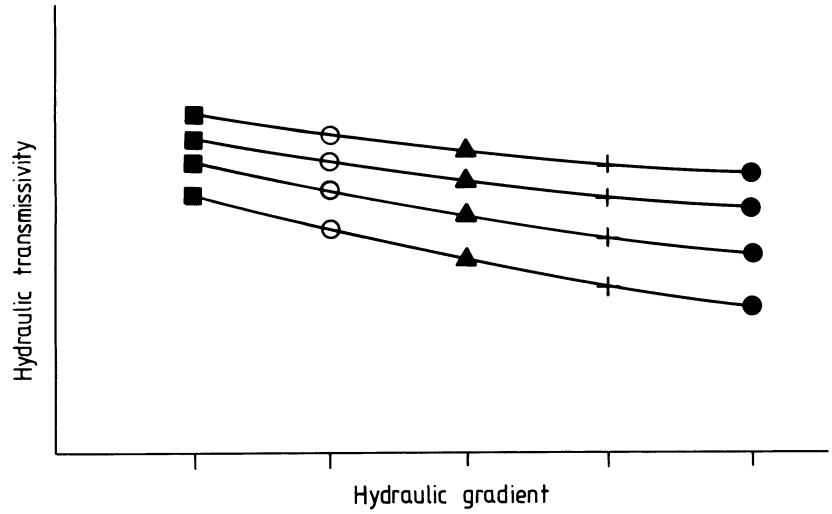

Figure 3 — Typical plot of hydraulic transmissivity versus hydraulic gradient under several normal stresses

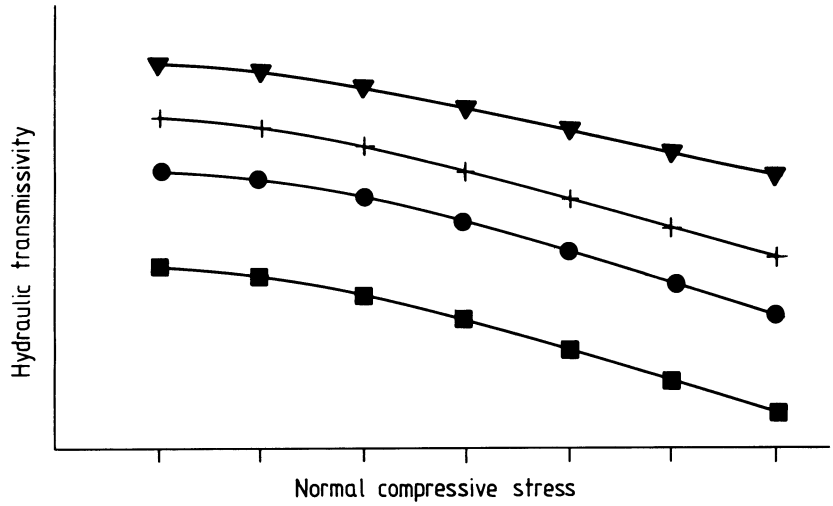

Figure 4 — Typical plot of hydraulic transmissivity versus normal compressive stress under several gradients

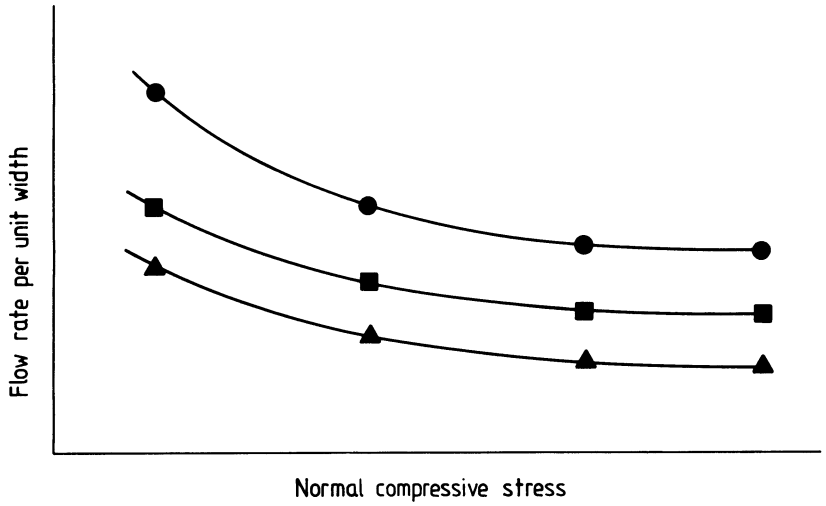

Figure 5 — Typical plot of flow rate per unit width versus normal compressive stress under several hydraulic gradients

Appendix A Accuracy

Based on the results of an interlaboratory trial, the variation of repeat measurements of the test is 5 % to 10 % coefficient of variation. The variation between specimens depends very much on the material and can be in the range of coefficients of variations between 10 % and 40 %.

blank

Publication(s) referred to

BS 2846, *Guide to statistical interpretation of data.*
BS 2846-2, *Estimation of the mean: confidence interval.*
BS 6096, *Methods of test for geotextiles.*
BS 6096-1, *Determination of the tensile properties using a wide width strip*[2)].
BS 6096-2, *Determination of the apparent pore size distribution by dry sieving*[2)].
BS 6096-3, *Determination of water flow normal to the plane of the geotextile under a constant head*[2)].
BS 6096-4, *Determination of the puncture resistance (CBR puncture test)*[2)].
BS 6096-5, *Determination of creep*[2)].
BS 6096-6, *Determination of resistance to perforation (cone drop test)*[2)].
BS 6096-8, *Method for investigating sand-geotextile frictional behaviour by direct shear*[2)].

[2)] Referred to in the foreword only.

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: 020 8996 9000. Fax: 020 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: 020 8996 9001. Fax: 020 8996 7001.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: 020 8996 7111. Fax: 020 8996 7048.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: 020 8996 7002. Fax: 020 8996 7001.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL