BS EN 675:2011

BSI Standards Publication

Glass in building — Determination of thermal transmittance (U value) — Heat flow meter method

bsi.

...making excellence a habit.™

National foreword

This British Standard is the UK implementation of EN 675:2011. It supersedes BS EN 675:1998 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/520/4, Properties and glazing methods.

A list of organizations represented on this committee can be obtained on request to its secretary.

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

ISBN 978 0 580 71596 9

ICS 81.040.20

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 June 2011.

Amendments issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 675

June 2011

ICS 81.040.20

Supersedes EN 675:1997

English Version

Glass in building - Determination of thermal transmittance (U value) - Heat flow meter method

Verre dans la construction - Détermination du coefficient de transmission thermique, U - Méthode du fluxmètre

Glas im Bauwesen - Bestimmung des Wärmedurchgangskoeffizienten (U-Wert) - Wärmestrommesser-Verfahren

This European Standard was approved by CEN on 12 May 2011.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN 675:2011: E

Contents

Page

Foreword

This document (EN 675:2011) has been prepared by Technical Committee CEN/TC 129 “Glass in building”, the secretariat of which is held by NBN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2011, and conflicting national standards shall be withdrawn at the latest by December 2011.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 675:1997.

The main change in this edition is that the internal and external heat transfer coefficients have been amended slightly to reflect changes to EN 673. Clarification is also given in the scope that the procedure specified in this European Standard should generally only be considered when the calculation method detailed in EN 673 is inappropriate or unsuitable.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

CEN/TC 129/WG 9 "Light and energy transmission, thermal insulation" prepared a working draft based on the document ISO/DIS 10293 "Glass in building - Determination of steady-state *U* values (thermal transmittance) of multiple glazing - Heat flow meter method", document that was prepared by ISO/TC 160, "Glass in building". This was published in 1997 as EN 675.

The document for the calculation of the overall *U* value of windows, doors and shutters (see [2]) gives normative reference to the *U* value evaluated for the glazing components according to this standard.

For the purposes of product comparison, a vertical position of the glazing is specified (see Clause 10).

U values evaluated according to the present standard are used for product comparison as well as for other purposes, in particular for predicting:

— heat loss through glazing;

— conduction heat gains in summer;

— condensation on glazing surfaces;

— the effects of the absorbed solar radiation in determining the solar factor (see [1]).

Reference should be made to [2], [3], [4] or other European Standards dealing with heat loss calculations for the application of glazing *U* values determined by this Standard.

1 Scope

This European Standard specifies a measurement procedure to determine the thermal transmittance of glazing with flat and parallel surfaces. For the purpose of this Standard, structured surfaces may be considered to be flat..

This European Standard applies to multiple glazing with outer panes which are not transparent to far infrared radiation (in the wavelength range 5µm to 50µm), which is the case for soda lime silicate glass products, borosilicate glass and glass ceramics. Internal elements can be far infrared transparent.

The procedure specified in this European Standard determines the *U* value (thermal transmittance) in the central area of glazing. The edge effects due to the thermal bridge through the spacer of an insulating glass unit or through the window frame are not included. Energy transfer due to solar radiation is also excluded.

The procedure specified in this European Standard should be considered only when the thermal transmittance of the glazing cannot be calculated in accordance with EN 673.

The determination of the thermal transmittance is performed for conditions which correspond to the average situation for glazing in practice.

NOTE Patterned glass is an example of a glass with a structured surface;

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.

EN 673, *Glass in building — Determination of thermal transmittance (U value) — Calculation method*

EN 12898, *Glass in building — Determination of the emissivity*

ISO 8301, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Heat flow meter apparatus*

ISO 8302, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Guarded hot plate apparatus*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply:

3.1
***U* value**
parameter of glazing which characterizes the heat transfer through the central part of the glazing, i.e. without edge effects, and states the steady-state density of heat transfer rate per temperature difference between the environmental temperatures on each side.

NOTE The *U* value is given in watts per square metre Kelvin [$W/(m^2 \cdot K)$]

3.2
declared value
U value obtained under standardized boundary conditions.

NOTE See 11.2.

4 Basic formula

The U value depends on the thermal resistance of the multiple glazing and on the external and internal surface heat transfer coefficients according to the relation:

$$\frac{1}{U} = R + \frac{1}{h_e} + \frac{1}{h_i} \tag{1}$$

where

R is the thermal resistance of the multiple glazing in square metres Kelvins per Watt $\left(m^2 \cdot K/W\right)$

h_e is the external surface heat transfer coefficient in watts per square metre Kelvin $\left[W / \left(m^2 \cdot K\right)\right]$

h_i is the internal surface heat transfer coefficient in watts per square metre Kelvin $\left[W / \left(m^2 \cdot K\right)\right]$

According to this standard the surface to surface thermal resistance is determined by measurements taken using the heat flow meter method. Thereupon the declared U value is determined according to Equation (1) with the values for the internal and external heat transfer coefficients specified in 11.2.

The external surface is the surface of the glazing intended to face the outside of the building in use. The internal surface is the surface of the glazing intended to face the inside of the building in use.

5 Brief outline of the measuring procedure

The surface to surface thermal resistance of the multiple glazing is determined by means of the heat flow meter method laid down in ISO 8301. The recommendations of that standard shall be complied with except for variations contained in this standard and for variations resulting from the special structure of the specimen.

Within the present context further requirements are necessary, viz. the size of the test specimens and the performance of the measurements are laid down to meet special requirements for measuring multiple glazing (see Clauses 6 to 13).

6 Test apparatus

For the measurement of the thermal resistance of the specimen, the single-specimen apparatus with symmetrical configuration or a double specimen apparatus as shown in Figures 1 and 2 is used.

The single-specimen apparatus consists of a heating and a cooling unit between which the specimen or a reference sample for the calibration of the apparatus is sandwiched. The cooling unit has surface dimensions as large as those of the heating unit.

A heat flow meter is positioned in the centre of the hot plate surface and the cold plate surface. These heat flow meters face each other on either sides of the specimen or the reference sample. On each side of the heat flow meters a thin natural or synthetic foam rubber sheet is placed to ensure sufficient thermal contact. Surface contact is obtained by applying pressure. The foam rubber sheets have the same dimensions as the surface area of the heating unit.

The double-specimen apparatus consists of a heating unit and two outer cooling units. The heating unit is sandwiched between the specimen to be measured and a control sample. For calibration a reference sample shall be introduced at the position of the specimen. On each side of the reference sample/specimen and the control sample heat flow meters are placed. On each side of the heat flow meters a thin foam rubber sheet is placed to ensure sufficient thermal contact. The surface dimensions of all elements and the positioning of the heat flow meters in the central area of the assembly are the same as for the single specimen apparatus.

For both apparatus the heating unit shall be of such a size as to completely cover the surface of the reference sample/specimen and in the case of the double apparatus of the control sample. Heat losses from the outer edges of the heat flow meter apparatus shall be restricted by edge insulation or by controlling the surrounding air temperature or by both.

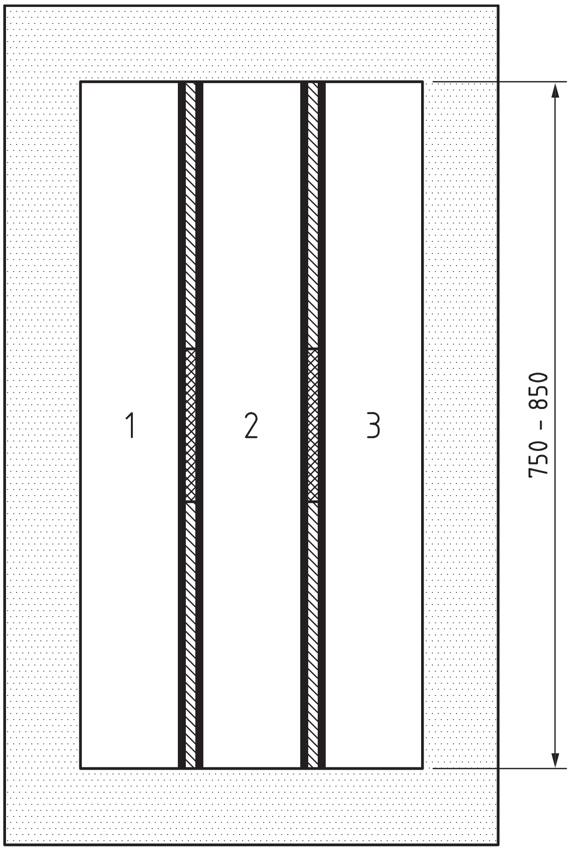
For both apparatus the metering area of the heat flow meters shall have a circular or square shape and a minimum size of 75 cm^2. Its maximum size shall lie within an area of 50 cm x 50 cm. The metering area shall further be surrounded by a protective zone consisting of the same material in the same thickness (with a tolerance of ± 0,1 mm) covering the whole sample area (see Figures 1 and 2).

Thermocouples are mounted in pairs. They are positioned to face each other and shall have direct contact to the surfaces of the reference sample/specimen and in the case of the double apparatus the control sample.

At least three thermocouple positions shall be chosen, one positioned in the centre of the metering area of the heat flow meters and two others diametrically opposite in a distance of 2/3 from the centre of the metering area to its perimeter. Additional thermocouples may be arranged in such a way that an optimum cover of the metering area is achieved.

Such thermocouples shall have a thickness not exceeding 0,2 mm; the junctions shall be flattened so as not to exceed 0,2 mm and a contact material (e.g. zinc oxide loaded silicon grease or metal tape) shall be used to insure a good thermal contact between the junction and the specimen.

Dimensions in millimetres



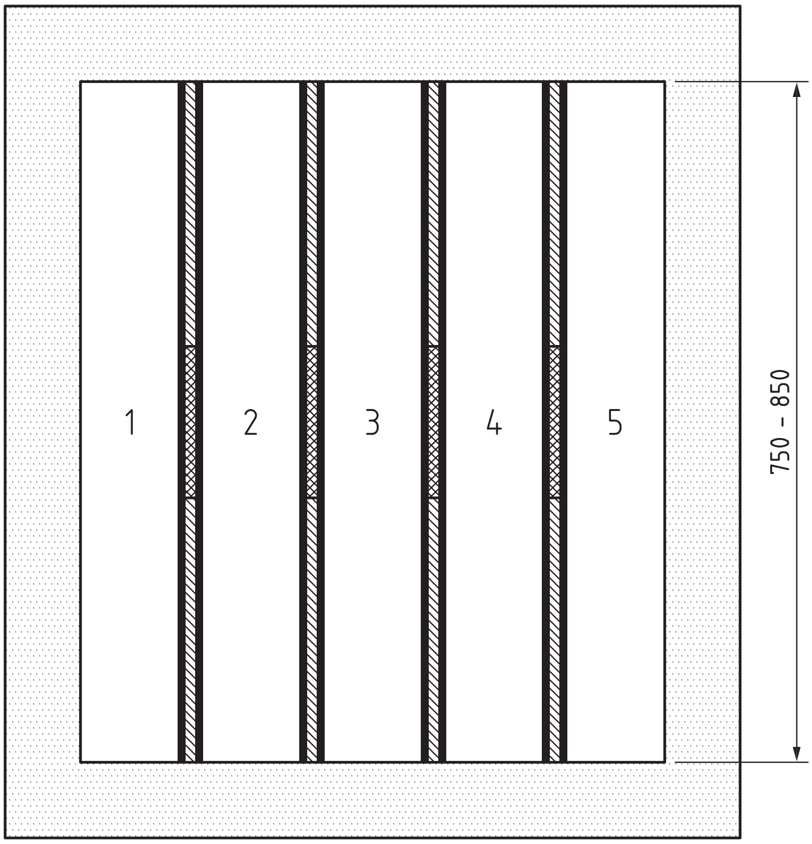
Key

- metering area of the heat flow meter
- insulating material
- protective zone
- thin foam rubber sheet

1 – heating unit
2 – specimen
3 – cooling unit”

Figure 1 — Single-specimen apparatus

Dimensions in millimetres



Key

metering area of the heat flow meter

insulating material

protective zone

thin foam rubber sheet

1 – cooling unit
2 – specimen
3 – heating unit
4 - control sample
5 – cooling unit

Figure 2 — Double-specimen apparatus

7 Calibration of the test apparatus

The heat flow meter method is a relative measuring method since the ratio of the thermal resistance of the specimen to that of a reference sample is evaluated. The thermal resistance of the reference sample shall be determined separately in accordance with ISO 8302 (*Guarded hot plate apparatus*). As a reference sample a homogeneous, non hygroscopic material with flat and parallel surfaces, with a heat resistance comparable to that of the specimen to be measured shall be used.

The heat flow density, Φ, in watts/m^2 transferred through the heat flow meter is computed from the voltage V (in volt) generated and the mean temperature T_m (in Kelvin) of the heat flow meter metering area according to the equation (2)

$$\Phi = (C_1 + C_2 T_m) \cdot V \tag{2}$$

where the constants C1 and C2 of the heat flow meter shall be determined by calibration using a reference sample.

Control of the equipment is done in the following way:

— when measurements are performed the calibration of both apparatus is done by measuring the reference sample with appropriate regularity;

— when measurements are performed using the double specimen apparatus the control sample gives an immediate control whether a general calibration shift of the apparatus occurs.

8 Dimensions of the specimens

The specimens shall be square and have dimensions of preferably 800 mm x 800 mm with a maximum spread ranging from 750 mm x 750 mm to 850 mm x 850 mm.

The surfaces of the specimens shall be flat and parallel.

Specimen sizes down to 450 mm x 450 mm may be used if it can be shown that no convection occurs in the gas space and that the errors occurring are not greater than those allowed for the 800 mm x 800 mm arrangement. For example, possible errors due to lateral heat flow through the glass of the specimen shall be carefully controlled.

For specimen sizes less than 800 mm x 800 mm the maximum allowed metering area of the heat flow meter (see Clause 6) shall be chosen in such a way that on all sides an edge area of the specimen in a width of at least 100 mm is not covered by the metering area.

9 Preparation of the specimens

The sum of the bowing or dishing of the outer panes in the central area of each specimen shall not exceed 0,5 mm. Bowing or dishing effects shall be minimized by cooling down the specimens to 10oC. Once isothermal equilibrium is reached, the bowing or dishing is measured immediately before

In the case of excessive bowing a correction of the thickness of the specimens in the central area may be performed by a corresponding pressure change. In the case of excessive dishing such a correction for gas fillings except air is only allowed if the needed correction by introducing a small volume of air does not exceed 0,5 mm.

10 Performance of the measurements

For the purpose of product comparison, the measurements shall be taken with the specimens in a vertical position.

However, for purposes other than product comparison, measurements may also be performed for other angles of inclination. Such an inclination and furthermore the direction of heat flow (upward and downward) shall be indicated in the test report

The measurements shall be performed at a mean temperature of each specimen of (10 ± 0,5) °C. The mean temperature difference between the hot and the cold surface of the specimens shall be (15 ± 0,5) K.

11 Evaluation of the results

11.1 Thermal resistance of the multiple glazing

The thermal resistance of the glazing, R, is calculated using the equation:

$$R = 2 \cdot (T_1 - T_2) / (\Phi_1 + \Phi_2) \quad \text{m}^2\cdot\text{K/W} \tag{3}$$

where

Φ_1 and Φ_2 are the heat flow densities (in W/m^2) obtained from the two heat flow meters facing the specimen to be measured;

T_1 and T_2 are the mean temperatures (in K) of the warm and cold surface area of the specimen facing the metering area of the heat flow meters.

11.2 Declared *U* value

The declared *U* value is calculated according to equation (1).

For multiple glazing without a coating having an emissivity lower than 0,837 on the outer surfaces, the following standardized values for the surface heat transfer coefficients are used:

— internal heat transfer coefficient: h_i = 7.7 W/(m^2·K);

— external heat transfer coefficient: h_e = 25 W/(m^2·K)

For a multiple glazing with a coating having an emissivity lower than 0,837 on the surface adjacent to the inner room, the standardized value of h_i is modified according to the equation:

$$h_i = 3{,}6 + 4{,}1 \frac{\varepsilon}{0{,}837} \quad \text{W/(m}^2\cdot\text{K)} \tag{4}$$

where

ε is the corrected emissivity of the surface;

0,837 is the corrected emissivity of uncoated soda lime silicate glass and borosilicate glass.

The corrected emissivity shall be determined by reference to EN 12898.

Values lower than 0,837 for ε shall be taken into account only if the surface is clean and water condensation on the coated surface can be excluded.

Improvements of the *U* value due to externally exposed coated surfaces with an emissivity lower than 0,837 are not taken into account.

NOTE The application of the *U* value of an external building element obtained in standard boundary condition for calculating heat losses is not strictly consistent on the basis of dry resultant temperature in internally heated spaces. In most practical cases it is adequate, but for glazing elements with relatively large surface area and particularly with internal low emissivity surface, errors may arise. In such cases reference is made to [3], [4] or other relevant European Standards.

11.3 Design U value

For the application of glazing U values in building design the use of a declared value may not always be sufficiently accurate. In special circumstances, a design value shall be determined using this standard. Design U values appropriate to the position of the glazing and the environmental conditions shall be determined using the correct boundary values of he and hi, which shall be stated.

12 Expression of results

12.1 *U* values

U values shall be expressed in $W/\left(m^2 \cdot K\right)$ rounded to one decimal figure. If the second decimal is five, it shall be rounded to the higher values.

EXAMPLE 1 1,53 becomes 1,5.

EXAMPLE 2 1,55 becomes 1,6.

EXAMPLE 3 1,549 becomes 1,5.

12.2 Thermal resistance

Thermal resistance shall be rounded to three decimal figures.

12.3 Intermediate values

Intermediate values shall not be rounded.

13 Test report

13.1 Identification of the specimens

The test report shall make reference to the current version of this Standard (i.e. EN 675) and the elements listed in 13.1, 13.2 and 13.3.

- length (mm);
- width (mm);
- total thickness measured at the edges (mm);
- thickness of each pane of glass or other glazing material (mm);

— thickness of gas space (s) measured at the edges (mm);

— type of gas filling (if known);

— position and emissivity of IR-reflecting coating(s) (if known);

— bowing or dishing in the central area (mm);

— corrected emissivity of surface adjacent to the inner room.

13.2 Cross section of the specimen

The figure showing the structure of the specimen (position and thickness of glass panes, position and thickness of gas space (s), type of gas filling, position of internal foils and of IR-reflecting coatings, etc.).

13.3 Results

— heat flow density (W/m^2);

— voltage (V);

— mean surface temperature on the hot side of the specimens (°C);

— mean surface temperature on the cold side of the specimens (°C);

— mean temperature difference between hot and cold side of the specimens (K);

— mean temperature of the specimens (°C);

— thermal resistance (m^2·K/W);

— corrected emissivity of the surface adjacent to the inner room in case of coatings which modify the emissivity;

— internal heat transfer coefficient h_i, in case of coatings which modify the emissivity [W/(m^2·K)];

— *U* value [W/(m^2·K)];

— for measurement of thermal resistance with a non-vertical position of the glazing, angle of inclination of the glazing and direction of heat flow (upward or downward);

— h_e and h_i if values different from the standardized ones are used to calculate a design *U* value, in which case the expression "design *U* value" shall be used [W/(m^2·K)].

Bibliography

[1] EN 410, *Glass in building — Determination of luminous and solar characteristics of glazing*

[2] EN ISO 10077-1, *Thermal performance of windows, doors and shutters — Calculation of thermal transmittance — Part 1: General* (ISO 10077-1:2006)

[3] EN ISO 10211, *Thermal bridges in building construction — Heat flows and surface temperatures — Part 1: Detailed calculations* (ISO 10211:2007)

[4] EN ISO 13790, *Energy performance of buildings — Calculation of energy use for space heating and cooling* (ISO 13790:2008)

This page deliberately left blank

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email bsmusales@bsigroup.com.

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Copyright

Useful Contacts:

Customer Services
Tel: +44 845 086 9001
Email (orders): orders@bsigroup.com
Email (enquiries): cservices@bsigroup.com

Subscriptions
Tel: +44 845 086 9001
Email: subscriptions@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

Copyright & Licensing
Tel: +44 20 8996 7070
Email: copyright@bsigroup.com

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

bsi.

...making excellence a habit.™