



BSI Standards Publication

<http://www.china-gauges.com/>

Paints and varnishes — Determination of water content — Gas-chromatographic method

National foreword

This British Standard is the UK implementation of [ISO 23168:2019](https://www.iso.org/standard/69411.html).

The UK participation in its preparation was entrusted to Technical Committee STI/10, Test methods for paints.

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.

© The British Standards Institution 2019
Published by BSI Standards Limited 2019

ISBN 978 0 539 01140 1

ICS 87.040

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 April 2019.

Amendments/corrigenda issued since publication

Date	Text affected
------	---------------

INTERNATIONAL
STANDARD

ISO
23168

First edition
2019-04-30

<http://www.china-gauges.com/>

**Paints and varnishes — Determination
of water content — Gas-
chromatographic method**

*Peintures et vernis — Détermination de la teneur en eau — Méthode
par chromatographie en phase gazeuse*



Reference number
ISO 23168:2019(E)

<http://www.china-gauges.com/>



COPYRIGHT PROTECTED DOCUMENT

© ISO 2019, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Page

Foreword.....	iv
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Principle	1
5 Apparatus	2
5.1 Gas chromatograph.....	2
5.2 Sample injection system.....	2
5.3 Oven.....	2
5.4 Detector.....	2
5.5 Capillary column.....	2
5.6 Injection syringe.....	2
5.7 Data processing.....	2
5.8 Sample vials.....	2
5.9 Gas filter.....	2
5.10 Carrier gas.....	3
5.11 Analytical balance.....	3
5.12 Bottle-top dispenser.....	3
6 Reagents and materials	3
6.1 Internal standard (anhydrous).....	3
6.2 Dilution solvent.....	3
6.3 Water.....	3
6.4 Molecular sieve.....	3
7 Sampling	3
8 Procedure	4
8.1 Gas-chromatographic conditions.....	4
8.2 Water content of the dilution solvent.....	4
8.3 Calibration.....	4
8.4 Sample preparation.....	4
8.5 Quantitative determination of water content.....	5
9 Expression of results	6
10 Precision	6
10.1 General.....	6
10.2 Repeatability limit, <i>r</i>	6
10.3 Reproducibility limit, <i>R</i>	6
11 Test report	7
Annex A (informative) Example of gas-chromatographic conditions	8
Annex B (informative) Information about precision	9
Bibliography	11

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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Paints and varnishes — Determination of water content — Gas-chromatographic method

1 Scope

This document specifies a method for the determination of the water content of water-borne coating materials and their raw materials by using a gas chromatograph. The preferred working range of this test method is from a water mass fraction of 1 % to a water mass fraction of 90 % but the method can be applied outside of this range.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 760, *Determination of water — Karl Fischer method (General method)*

[ISO 1513](#), *Paints and varnishes — Examination and preparation of test samples*

[ISO 3696](#), *Water for analytical laboratory use — Specification and test methods*

[ISO 4618](#), *Paints and varnishes — Terms and definitions*

[ISO 15528](#), *Paints, varnishes and raw materials for paints and varnishes — Sampling*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in [ISO 4618](#) and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at <https://www.iso.org/obp>

— IEC Electropedia: available at <http://www.electropedia.org/>

3.1

ready for use

state of a product when it is mixed in accordance with the manufacturer's instructions in the correct proportions and thinned if required using the correct thinners so that it is ready for application by the approved method

[SOURCE: ISO 11890-2:2013, 3.4]

4 Principle

A suitable amount of the sample is internally standardized, diluted with appropriate organic solvent, and then injected into a gas chromatographic column that separates water from other components, after which the water is detected by a thermoconductivity detector and quantified from the peak areas using the internal standard.

5 Apparatus

5.1 Gas chromatograph

The apparatus shall be set up and used in accordance with the manufacturer's instructions. All of the instrumental parts coming into contact with the test sample shall be made of a material (e.g. glass) which is resistant to the sample and will not change it chemically.

5.2 Sample injection system

The instrument shall have a variable-temperature injection block with a sample splitter. The injection temperature shall be capable of being set to an accuracy of 1 °C. The split ratio shall be adjustable and capable of being monitored. The sample splitter insert shall contain silanized glass wool to retain nonvolatile constituents, and shall be cleaned and provided with new glass wool packing or replaced as required to eliminate errors due to residues of binder or pigment (i.e. adsorption of compounds).

5.3 Oven

The oven shall be capable of being heated between 40 °C and 300 °C both isothermally and under programmed temperature control. It shall be possible to set the oven temperature to within 1 °C. The final temperature of the temperature programme shall not exceed the maximum operating temperature of the column (see 5.5).

5.4 Detector

Thermoconductivity detector (TCD), capable of being operated at temperatures up to 300 °C. The injection volume, split ratio and gain setting shall be optimized so that the signals (peak areas) used for the calculation are proportional to the amount of substance.

5.5 Capillary column

The column shall be made of glass or fused silica. Columns of sufficient length to resolve water and of maximum internal diameter 0,53 mm, based on bonded porous polymer technology shall be used. Columns should also show good stability and reproducibility with samples containing large amounts of water. Other columns proved to be equally suitable may also be used.

5.6 Injection syringe

The injection syringe shall have a capacity of at least twice the volume of the sample to be injected into the gas chromatograph.

5.7 Data processing

A suitable software shall be used for integration, calibration, quantification and other data handling processes.

5.8 Sample vials

Use vials made of chemically inert material (e.g. glass) which can be sealed with a suitable septum cap [e.g. a rubber membrane coated with poly(tetra fluoro ethylene)].

5.9 Gas filter

A filter shall be installed in the gas chromatograph connection pipes to adsorb residual impurities in the gas (see 5.10).

Care should be taken that any moisture that might be present in the carrier gas is eliminated through the use of a suitable carrier gas purifier. Trace levels of water will accumulate on the column at low oven temperatures and might affect the reproducibility as well as the accuracy of the determination.

5.10 Carrier gas

Hydrogen of 99,995 % or higher purity. High-purity helium may also be used.

5.11 Analytical balance

Capable of weighing to an accuracy of 0,1 mg.

5.12 Bottle-top dispenser

Dispensers shall be equipped with a drying tube. All parts of the dispensers shall be inert to the solvents used.

6 Reagents and materials

During the analysis, use only reagents of recognized analytical grade. Other grades may also be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

6.1 Internal standard (anhydrous)

The internal standard shall be a compound which is not present in the sample and is completely separated from the other components in the chromatogram. It shall be inert with respect to the sample constituents, stable in the required temperature range, and of known purity. Dry the internal standard with the molecular sieve (6.4). Dispense the internal standard with the bottle-top dispenser (5.12).

NOTE 2-propanol or n-propanol has been found suitable.

6.2 Dilution solvent

Use an organic solvent suitable for diluting the sample. It shall have a purity of at least 99 % (mass fraction) or shall be of known purity, and it shall not contain any substances which interfere with the determination, e.g. causing overlapping peaks in the chromatogram. Always carry out a separate run injecting the solvent alone in order to observe contaminants and possible interference peaks, especially in trace analysis. Dry the dilution solvent with the molecular sieve (6.4). Dispense the dilution solvent with the bottle-top dispenser (5.12).

NOTE Dimethylformamide (DMF) has been found suitable.

6.3 Water

Water conforming to the requirements of grade 3 or higher of [ISO 3696](#) shall be used.

6.4 Molecular sieve

Pore diameter: 2 Å to 3 Å (= 2×10^{-7} mm to 3×10^{-7} mm); particle size: 1,7 mm to 5,0 mm.

The molecular sieve shall be regenerated before use.

7 Sampling

Take a representative sample of the product to be tested (or of each product in the case of a multi-coat system), as specified in [ISO 15528](#).

Examine and prepare each sample for testing, as specified in [ISO 1513](#), preparing the final sample for testing in the “ready for use” state.

8 Procedure

8.1 Gas-chromatographic conditions

The gas-chromatographic conditions used depend on the product to be analysed and shall be optimized each time using a known calibration mixture. Examples of gas-chromatographic conditions are given in [Annex A](#).

The injection volume and the split ratio shall be determined so as not to exceed the capacity of the column and to remain within the linear range of the detector. Asymmetrical peaks will give an indication of overloading of the gas-chromatographic system.

8.2 Water content of the dilution solvent

Determine the water content of the dilution solvent ([6.2](#)) by Karl Fischer titration method as described in ISO 760.

8.3 Calibration

The response factor shall be determined using the following technique.

Weigh about 0,4 g of water ([6.3](#)) and 0,4 g of internal standard ([6.1](#)), to the nearest 0,1 mg, into a sample vial ([5.8](#)). Weigh about 10,0 g of dilution solvent ([6.2](#)) into the same vial ([5.8](#)), to the nearest 0,1 mg. If the dilution solvent ([6.2](#)) is anhydrous, simply add 10 ml of it as weighing is not necessary.

Inject 0,1 µl to 1,0 µl of the calibration mixture twice under the conditions specified in [8.1](#). From each calibration chromatogram, calculate the response factor for water using [Formula \(1\)](#):

$$r_w = \frac{(m_{cw} + m_{ds} \times P) \times A_{is}}{m_{is} \times A_{cw}} \quad (1)$$

where

- r_w is the response factor for water;
- P is the water content, in grams per gram, of the dilution solvent (see [8.2](#));
- m_{ds} is the mass, in grams, of the dilution solvent;
- m_{is} is the mass, in grams, of the internal standard in the calibration mixture;
- m_{cw} is the mass, in grams, of water intentionally added to the calibration mixture;
- A_{is} is the peak area of the internal standard;
- A_{cw} is the peak area of water in the calibration mixture.

Calculate the mean value (\bar{r}_w) of the two calibration response factors.

8.4 Sample preparation

The mass of the sample depends on the expected water content w (see [Table 1](#)).

Table 1 — Mass of sample

Expected water content, w % (mass fraction)	Mass of sample g
$15 \leq w \leq 30$	2,0

Expected water content, w % (mass fraction)	Mass of sample g
$30 < w \leq 50$	1,0
$50 < w \leq 70$	0,7
$70 < w \leq 90$	0,5

Weigh to the nearest 0,1 mg, the sample and about 0,4 g of the internal standard (6.1) into the sample vial (5.8). Weigh about 10,0 g of dilution solvent (6.2) into the same vial (5.8), to the nearest 0,1 mg. If the dilution solvent (6.2) is anhydrous, simply add 10 ml of it as weighing is not necessary. Seal the vial, shake the vials on a wrist action shaker or other suitable device for 15 min. To facilitate setting of solids, allow the vials to stand for a suitable time just prior to injection into the chromatograph. If particles do not readily settle, phase cleaning may be obtained by centrifugation.

NOTE Dry mixing glass beads added to the vials have proved beneficial with viscous samples.

8.5 Quantitative determination of water content

Set the instrumental parameters as specified in 8.1.

Inject 0,1 μl to 1 μl of the "ready for use" sample into the gas chromatograph and record the chromatogram. Determine the peak areas for water and the internal standard. Determine the water content of the sample using Formula (2):

$$w_{sw} = \bar{r}_w \times \frac{m_{is} \times A_{sw}}{m_s \times A_{is}} \times 100 \quad (2)$$

where

- w_{sw} is the water content, as a percentage mass fraction, of the sample;
- \bar{r}_w is the mean value of the two calibration response factors for water;
- m_{is} is the mass, in grams, of the internal standard in the calibration mixture;
- m_s is the mass, in grams, of the sample;
- A_{is} is the peak area of the internal standard;
- A_{sw} is the peak area of water of the test sample.

Repeat the procedure.

If the blank indicates the presence of a detectable peak for water in the solvent (6.2), apply a correction in the calculation by using Formula (3) and Formula (4):

$$w_{dsw} = \frac{m_{ds} \times P}{m_s} \times 100 \quad (3)$$

where

w_{dsw} is the water content, as a percentage mass fraction, due to the dilution solvent;

m_{ds} is the mass, in grams, of the dilution solvent;

P is the water content, in grams per gram, of the dilution solvent (see 2.1),

m_{s} is the mass, in grams, of the sample.

$$w_{\text{csw}} = w_{\text{sw}} - w_{\text{dsw}} \quad (4)$$

where

w_{csw} is the water content, as a percentage mass fraction, of the sample by correction;

w_{sw} is the water content, as a percentage mass fraction, of the sample;

w_{dsw} is the water content, as a percentage mass fraction, due to the dilution solvent.

9 Expression of results

If the two results (duplicates) differ by more than the maximum value indicated in [10.2](#), repeat the procedure. Calculate the mean of two valid results (replicates). Mass fractions shall be reported at least to the nearest 0,1 %.

10 Precision

10.1 General

The precision of the test method was determined by interlaboratory testing in accordance with [ISO 5725-1](#) and [ISO 5725-2](#). Details can be found in [Annex B](#).

10.2 Repeatability limit, r

The repeatability limit, r , is the value below which the absolute difference between two single test results, each the mean of duplicates, obtained on identical material by one operator in one laboratory within a short interval of time using the standardized test method, may be expected to lie.

The repeatability for four repeated determinations made using this test method, expressed as the repeatability coefficient of variation, lies between 0,2 % and 1,0 %.

10.3 Reproducibility limit, R

The reproducibility limit, R , is the value below which the absolute difference between two test results, each the mean of duplicates, obtained on identical material by operators in different laboratories using the standardized test method, might be expected to lie.

The reproducibility for this test method, expressed as the reproducibility coefficient of variation, lies between 0,6 % and 3,0 %.

11 Test report

The test report shall contain at least the following information:

- a) all details necessary for complete identification of the tested product (manufacturer, trade name, batch number, etc.);
- b) a reference to this document (i.e. [ISO 23168:2019](#));
- c) the gas-chromatographic conditions to be used (see [8.1](#));
- d) the results of the test, as indicated in [8.5](#), and the method of calculation used (see [8.5](#));
- e) the dilution solvent used;
- f) any deviation from the test method specified;
- g) any unusual features (anomalies) observed during the test;
- h) the date of the test.

Annex A
 (informative)

Example of gas-chromatographic conditions

Detector	Thermal conductivity
Column	CP-PoraBond Q ^a), bonded with poly(styrene-divinylbenzene), 25 m × 0,53 mm × 1 μm
Injector temperature	250 °C
Detector temperature	300 °C
Programme	Initial temperature: 100 °C First isothermal holding time: 2 min Heating rate: 20 °C/min Second isothermal holding temperature: 130 °C Holding time: 3 min Heating rate: 30 °C/min Final temperature: 200 °C Isothermal holding time: 5 min
Carrier gas	Hydrogen
Flow rate	6,5 ml/min
Injection volume	1 μl
Split ratio	1:5

Annex B (informative)

Information about precision

An interlaboratory test was conducted on nine different materials by three laboratories. The experiment data obtained with the method specified in this document are presented in [Table B.1](#) and the comparison with Karl Fischer is given in [Table B.2](#). The details of the test results can be seen in [Table B.3](#).

Table B.1 — Testing data for water content (% , mass fraction)

Item	Lab	Sample1 %	Sample2 %	Sample3 %	Sample4 %	Sample5 %	Sample6 %	Sample7 %	Sample8 %	Sample9 %
1	A	16,131	17,987	23,189	39,493	44,819	53,231	67,613	78,272	81,522
		16,141	17,909	23,624	39,282	44,466	53,591	68,647	78,177	81,575
		16,147	18,044	23,412	39,337	44,614	53,512	68,204	77,900	81,681
		16,010	18,110	23,479	39,642	44,744	53,461	68,533	78,087	80,930
2	B	16,385	18,105	22,990	38,660	42,663	52,151	67,866	76,883	80,222
		16,073	17,921	23,039	38,840	43,094	52,447	67,959	77,226	80,256
		16,008	17,970	23,207	38,840	42,201	51,578	67,860	77,060	80,241
		16,237	18,100	23,068	38,854	42,944	51,893	68,254	77,306	80,432
3	C	16,040	17,469	23,001	39,342	42,635	54,837	67,042	78,036	81,133
		16,012	17,589	22,981	38,779	44,339	53,208	67,576	77,177	81,257
		16,165	17,685	23,582	39,065	43,733	53,652	67,064	77,599	80,064
		16,563	17,691	22,939	38,573	44,045	53,553	67,197	77,555	80,528

Table B.2 — Comparison with Karl Fischer Method

	Sample1 %	Sample2 %	Sample3 %	Sample4 %	Sample5 %	Sample6 %	Sample7 %	Sample8 %	Sample9 %
Gas-chromatographic method	16,159	17,882	23,209	39,059	43,691	53,093	67,818	77,606	80,820
Karl Fischer method	15,914	17,678	22,900	39,595	44,140	53,369	67,005	77,913	81,053
Deviation value	0,245	0,204	0,309	-0,536	0,449	-0,276	0,813	-0,307	-0,233

Table B.3 — Results of interlaboratory testing

Parameter	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9
Number of laboratories	3	3	3	3	3	3	3	3	3
Number of repeated determinations	4	4	4	4	4	4	4	4	4

Parameter	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9
Mean value, % (mass fraction)	16,16	17,88	23,21	39,06	43,69	53,09	67,82	77,61	86,88
Reproducibility standard deviation	0,16	0,22	0,23	0,34	0,92	0,89	0,54	0,47	0,57
Reproducibility coefficient of variation	0,99	1,2	0,99	0,87	2,1	1,7	0,77	0,61	0,71
Repeatability standard deviation	0,16	0,082	0,18	0,19	0,43	0,41	0,28	0,21	0,33
Repeatability coefficient of variation	0,99	0,46	0,78	0,49	0,98	0,77	0,41	0,27	0,41

Bibliography

- [1] [ISO 5725-1](#), *Accuracy (trueness and precision) of measurement methods and results — Part 1: General principles and definitions*
- [2] [ISO 5725-2](#), *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*
- [3] [ISO 11890-2:2013](#), *Paints and varnishes — Determination of volatile organic compound (VOC) content — Part 2: Gas-chromatographic method*
- [4] ASTM D3792-16, *Standard Test Method for Water Content of Coatings by Direct Injection into a Gas Chromatograph*
- [5] Chinese National Standard GB 18582, *Indoor decorating and refurbishing materials — Limit of harmful substances of interior architectural coatings*

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.

Copyright in BSI publications

All the content in BSI publications, including British Standards, is the property of and copyrighted by BSI or some person or entity that owns copyright in the information used (such as the international standardization bodies) and has formally licensed such information to BSI for commercial publication and use.

Save for the provisions below, you may not transfer, share or disseminate any portion of the standard to any other person. You may not adapt, distribute, commercially exploit, or publicly display the standard or any portion thereof in any manner whatsoever without BSI's prior written consent.

Storing and using standards

Standards purchased in soft copy format:

- A British Standard purchased in soft copy format is licensed to a sole named user for personal or internal company use only.
- The standard may be stored on more than 1 device provided that it is accessible by the sole named user only and that only 1 copy is accessed at any one time.
- A single paper copy may be printed for personal or internal company use only.
- Standards purchased in hard copy format:
- A British Standard purchased in hard copy format is for personal or internal company use only.
- It may not be further reproduced – in any format – to create an additional copy. This includes scanning of the document.

If you need more than 1 copy of the document, or if you wish to share the document on an internal network, you can save money by choosing a subscription product (see 'Subscriptions').

Reproducing extracts

For permission to reproduce content from BSI publications contact the BSI Copyright & Licensing 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 subscriptions@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.

Useful Contacts

Customer Services

Tel: +44 345 086 9001

Email (orders): orders@bsigroup.com

Email (enquiries): cservices@bsigroup.com

Subscriptions

Tel: +44 345 086 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