BS ISO 22068:2012

BSI Standards Publication

Sintered-metal injection-moulded materials — Specifications

raising standards worldwide™

National foreword

This British Standard is the UK implementation of ISO 22068:2012.

The UK participation in its preparation was entrusted to Technical Committee ISE/65, Sintered metal components.

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 66489 2

ICS 77.160

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 2012.

Amendments issued since publication

Date	Text affected

BS ISO 22068:2012

INTERNATIONAL STANDARD

ISO 22068

First edition
2012-07-01

Sintered-metal injection-moulded materials — Specifications

Matériaux métalliques frittés pour moulage par injection — Spécifications

Reference number
ISO 22068:2012(E)

Contents

Page

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 22068 was prepared by Technical Committee ISO/TC 119, *Powder metallurgy*, Subcommittee SC 5, *Specifications for powder metallurgical materials (excluding hardmetals)*.

Sintered-metal injection-moulded materials — Specifications

1 Scope

This International Standard specifies the requirements for the chemical composition and the mechanical and physical properties of sintered-metal injection-moulded materials.

It is intended to provide design and materials engineers with necessary information for specifying materials in components manufactured by means of the Metal Injection Moulding (MIM) process only.

It does not apply to structural parts manufactured by other powder metallurgy routes, such as press-and-sinter or powder-forging technologies.

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.

ISO 2740, *Sintered materials, excluding hardmetals — Tensile test pieces*

ISO 3369, *Impermeable sintered metal materials and hardmetals — Determination of density*

ISO 4498, *Sintered metal materials, excluding hardmetals — Determination of apparent hardness and micro-hardness*

ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method*

ISO 6508-1, *Metallic materials — Rockwell hardness test — Part 1: Test method (scales, A, B, C, E, F, G, H, K, N, T)*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

ISO 9227, *Corrosion tests in artificial atmospheres — Salt spray tests*

IEC 60404-4, *Magnetic materials — Part 4: Methods of measurement of d.c. magnetic properties of magnetically soft materials*

ASTM D2638, Standard Test Method for *Real Density of Calcined Petroleum Coke by Helium Pycnometer*

ASTM D4892, *Standard Test Method for Density of Solid Pitch (Helium Pycnometer Method)*

3 Terms and definitions

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

3.1
tensile strength
R_m
ability of a test specimen to resist fracture when a pulling force is applied in a direction parallel to its longitudinal axis, expressed in MPa

3.2
tensile yield strength
$R_{p0,2}$
load at which the material exhibits a 0,2 % offset from proportionality on a stress-strain curve in tension, divided by the original cross-sectional area, expressed in MPa

3.3
elongation
A_{25}
plastic elongation, expressed as a percentage of the original gauge length of the specimen

NOTE The elastic strain at the 0,2 % yield strength must be subtracted from the total elongation to give the plastic elongation.

3.4
density
mass per unit volume of the material, expressed in g/cm^3

3.5
hardness
resistance of a PM material to indentation, tested under specified conditions

4 Test methods for normative properties

4.1 General

The following test methods shall be used to determine the normative properties given in Tables 1 to 6.

4.2 Chemical composition

Whenever possible, and always in cases of dispute, the methods of chemical analysis shall be those specified in the relevant International Standards. If no International Standard is available, the method may be agreed upon and specified at the time of enquiry and order.

4.3 Density

The density shall be determined in accordance with ISO 3369 or by gas pycnometer measurement in accordance with ASTM D2638 or ASTM D4892 as stipulated at the time of enquiry and order.

4.4 Tensile strength

The ultimate tensile strength shall be determined in accordance with ISO 2740 and ISO 6892-1.

4.5 Tensile yield strength

The tensile yield strength shall be determined in accordance with ISO 2740 and ISO 6892-1.

4.6 Elongation

The elongation shall be determined in accordance with ISO 2740 and ISO 6892-1.

4.7 Magnetic properties

The maximum permeability and magnetic induction at an applied field of 1 990 A/m (25 Oe) shall be determined in accordance with IEC 60404-4.

5 Other test methods

5.1 Hardness

The hardness shall be determined in accordance with ISO 4498, ISO 6507-1 and ISO 6508-1.

5.2 Corrosion resistance

Four corrosive media and test methods (see 5.2.1 to 5.2.4) are used to rate the corrosion resistance of MIM stainless-steel alloys.

5.2.1 Sulfuric acid test

The standard un-notched Charpy test specimens (10 mm × 5 mm × 55 mm) are immersed in a 2 % by mass sulfuric acid solution at room temperature for 1 000 h. Three replicates are tested. The loss in mass for each is determined in accordance with MPIF Standard 62, and then converted into mass loss per surface area per day in units of gram per square decimetre day [g/(dm^2)(day)].

5.2.2 Copper sulfate test

The test specimens or test parts are immersed in a copper sulfate solution (dissolve 1 g of cupric sulfate crystals in a mixture of 22,5 ml of distilled water and 2,5 g of sulfuric acid) for 6 min (± 30 s) at a temperature of 17 to 20 °C. Specimens that show no sign of copper plating are classified as passing this test (see ASTM F1089).

5.2.3 Boiling water test

The test specimen or test parts are immersed in distilled water, then brought to a boil and held for (30 ± 1) min. After the 30 min exposure remove from the heat source and let the specimens remain in the water for 3 h ± 15 min. The specimens are then removed and left to dry in still air for 2 h ± 10 min. Specimens that show no visible corrosion are classified as passing this test (see ASTM F1089).

5.2.4 Salt spray test

Criteria for the salt spray test in accordance with ISO 9227 shall be determined between the manufacturer and the customer.

6 Information and explanatory notes

6.1 Minimum value concept

This International Standard has adopted the concept of minimum mechanical and magnetic property values. These values may be used for determining the material most suited for a particular application if the part is manufactured by means of the MIM process.

6.2 Minimum mechanical property values

The minimum values for the MIM materials are expressed in terms of ultimate tensile strength, yield strength (0,2 % offset), and percent elongation to fracture. Values are reported for structural materials in both the as-sintered and heat-treated condition (where applicable).

The tensile properties used for establishing this International Standard were obtained from tensile specimens prepared according to ISO 2740. Tensile properties obtained from test specimens prepared by machining of non-standard specimens, or from non-standard specimens directly, may differ from those prepared according to ISO 2740. Evidence of mechanical properties for a particular component shall therefore be based on the tensile properties measured using specimens prepared according to ISO 2740. These specimens shall be manufactured from the same batch of material as the components, have the same density and be sintered and heat treated (if required) along with the components.

Defects introduced during the MIM processing of particular components may limit the tensile properties. Non-destructive evaluation of the parts can be necessary to ensure that the minimum property specifications according to this International Standard are met, if proof testing is not used.

6.3 Proof testing

The practical method for demonstrating the strength of a component is through static or dynamic testing stipulated by the supplier and/or user of the MIM part. This proof test should be as closely related to the actual function of the part as possible, as provided by break load, bend test, pull test, etc. For example, it may be agreed that the break load should be greater than a given value. If that load is exceeded in proof tests, the minimum strength is demonstrated. In an alternative method, the first batch of parts can also be tested in service and demonstrated to be acceptable. The static or dynamic load to fracture is determined separately and these data are statistically analysed to determine a minimum break load for future production batches. Exceeding that minimum load on future lots of these parts is proof that the specified strength requirement has been met.

6.4 Chemical composition

The chemical composition of each material lists the principal alloying elements by minimum and maximum percentage. Other elements include the total other elements by difference and are listed as a maximum value in mass percent.

6.5 Density and residual porosity

MIM materials are normally processed to near full density. If not otherwise specified, MIM materials contain less than 5 % residual porosity. The pores are finely dispersed, mainly within the grains, well rounded and have no access to the surface of the component, which means that MIM materials are impermeable to gases or liquids.

6.6 Heat treatment

Many MIM materials may be heat treated to increase strength, hardness and wear resistance. Ferrous MIM parts which contain at least 0,3 % carbon can be quench-hardened and tempered. Tempering is required after quenching for stress relief and optimization of strength and toughness. These two properties can be varied over a wide range using different tempering temperatures. The hardness level obtained after heat treatment shall be stated for quenched and tempered steels. Case hardening (carburizing or carbo-nitriding) can also be applied to ferrous MIM materials with less than 0,3 % carbon to obtain high surface hardness.

The mechanical properties listed in this International Standard for the heat-treated condition are minimum values obtained at the practical lowest and highest apparent hardness levels attained with different tempering temperatures.

Martensitic stainless steels (MIM-420) and precipitation-hardened stainless steels (MIM-174PH) can also be heat treated for increased strength and hardness.

MIM materials respond well to conventional heat-treating practices and procedures in gas atmosphere or in a vacuum.

7 Designation of materials

7.1 Designation system

The designation system to be used for metal injection-moulded materials specified in this International Standard is in accordance with the ISO/IEC Directives, Part 2:2004.

7.2 Description block

The description block shall contain the letters MIM, denoting powder metallurgy materials made using the metal injection-moulding process.

7.3 Identity block

The identity block shall contain the number of this International Standard, ISO 22068, followed by the individual item block.

7.4 Individual item block

The coding system utilizes two different methods: for unique MIM alloys that do not exist as wrought compositions the material designation is an abbreviated code for the alloy composition where the major element is listed first, followed by the minor alloying elements, preceded by the numerical mass percentage value. If the material is a low-alloy steel containing carbon, the C designation is the last element listed with no numerical value given. The range of carbon required for the alloy is listed in the data table. For example, the alloy Fe-2 %Ni has the designation Fe2Ni; if this alloy has carbon added, the material designation code is Fe2NiC. For alloys that have recognized wrought composition codes, these material designations codes are used to identify the equivalent MIM alloy. For example, the stainless steels use a corresponding wrought steel grade wherever possible, e.g. 316L stainless steel or 420 stainless steel. Following the material designation code is a hyphen and then the numeric value of the yield strength in MPa units, e.g., MIM-Fe2NiC-205.

Heat-treated steels and stainless steels include in the material designation an “H” following the material code to signify a heat-treated material. The complete code has three or four numerals preceding the “H” where these numbers are the normative tensile yield strength value, in MPa units. For example, MIM-4340- 750H designates a heat-treated, low-alloy steel with nominally 0,4 % carbon, 2 % nickel, 1 % chromium and a minimum tensile yield strength of 750 MPa.

In the case of the soft-magnetic alloys, the two or three digit number following the material code is the normative maximum permeability value multiplied by 0,01, not the minimum tensile strength as in structural steels or stainless steels. For example, the MIM-Fe3Si-55 designation indicates a steel alloy with no carbon and 3 % silicon with a normative maximum permeability value of 5 500.

The identity block is not used in the tables of materials specifications in this International Standard. It should be used on purchase and for technical documentation where any possibility of ambiguity exists. Hence **MIM-ISO22068-Fe2NiC-205** is an example of a purchase order entry showing the identity block in conjunction with the individual item block.

8 Material specifications

MIM materials are specified in the Tables 1 to 6. The list represents the current status of standardization. Normative values of tensile strength (UTS), yield strength (YS) and percent elongation to fracture are minimum values for the as-sintered and heat-treated structural alloys. The normative values for the soft-magnetic alloys are the minimum values for density, maximum permeability and maximum induction at 1990 A/m (25 Oe). The steel alloys are listed as low-alloy steels in Tables 1 and 2, the stainless-steel alloys in Table 3 and 4, the soft-magnetic alloys in Table 5 and the titanium alloys in Table 6. The materials in each table are arranged in order of increasing content of alloying elements.

Table 1 — Low-alloy steels – As-sintered

Grade	Normative values											Informative (typical) properties		
	Chemical composition								Ultimate tensile strength	Yield strength	Elongation	Density	Macro-apparent hardness	
	Fe	C	Si	Mn	Ni	Cr	Mo	Others	min.	(0,2 %) min.	min.		Rockwell	Vickers
	%	%	%	%	%	%	%	%	R_m MPa	$R_{p0,2}$ MPa	A_{25} %	ρ g/cm³	HRB	HV10
MIM-Fe2Ni-110	Bal.	<0,1	<1,0	—	1,5-2,5	—	<1,0	<1,0	255	110	20	7,6	45	87
MIM-Fe2NiC-205	Bal.	0,4-0,8	<1,0	—	1,5-2,5	—	<0,5	<1,0	380	205	11	7,6	80	150
MIM-Fe8Ni-210	Bal.	<0,1	<1,0	—	6,5-8,5	—	<0,5	<1,0	380	210	20	7,6	69	123
MIM-Fe8NiC-300[a]	Bal.	0,4-0,8	<1,0	—	6,5-8,5	—	<0,5	<1,0	550	300	6	7,6	90	180
MIM-Fe8NiC-500[a]	Bal.	0,4-0,8	<1,0	—	6,5-8,5	—	<0,5	<1,0	750	500	5	7,6	100	250
MIM-4140-400	Bal.	0,35-0,50	<0,4	<0,9	—	0,9-1,2	0,15-0,30	<1,0	700	400	3	7,4	95	210
MIM-4340-500	Bal.	0,35-0,50	<0,4	<0,8	1,4-2,0	0,7-1,4	0,2-0,3	<1,0	700	500	4	7,4	100	240
MIM-4605-170	Bal.	0,4-0,6	<1,0	—	1,5-2,5	—	0,2-0,5	<1,0	380	170	11	7,5	80	150
MIM-52100-450[a]	Bal.	0,8-1,05	<0,4	<0,8	—	1,35-1,65	—	<1,0	750	450	3	7,4	95	200
MIM-52100-630[a]	Bal.	0,8-1,05	<0,4	<0,8	—	1,35-1,65	—	<1,0	950	630	5	7,4	100	250

[a] The mechanical properties depend on the sintering conditions. Faster cooling results in higher strength.

Table 2 — Low-alloy steels – Heat treated

Grade	Normative values											Informative (typical) properties		
	Chemical composition								Ultimate tensile strength	Yield strength	Elongation	Density	Macro-apparent hardness	
	Fe	C	Si	Mn	Ni	Cr	Mo	Others	min.	(0,2 %) min.	min.		Rockwell	Vickers
	%	%	%	%	%	%	%	%	R_m MPa	$R_{p0,2}$ MPa	A_{25} %	ρ g/cm^3	HRC	HV10
MIM-Fe2NiC-700H	Bal.	0,4-0,8	<1,0	—	1,5-2,5	—	<0,5	<1,0	800	700	5	7,6	30	300
MIM-Fe2NiC-1000H	Bal.	0,4-0,8	<1,0	—	1,5-2,5	—	<0,5	<1,0	1 200	1 000	2	7,6	50	510
MIM-Fe8NiC-700H	Bal.	0,4-0,8	<1,0	—	6,5-8,5	—	<0,5	<1,0	800	700	5	7,6	35	345
MIM-Fe8NiC-1100H	Bal.	0,4-0,8	<1,0	—	6,5-8,5	—	<0,5	<1,0	1 300	1 100	2	7,6	50	510
MIM-4140-600H	Bal.	0,35-0,50	<0,4	<0,9	—	0,9-1,2	0,15-0,30	<1,0	750	600	3	7,4	25	265
MIM-4140-1200H	Bal.	0,35-0,50	<0,4	<0,9	—	0,9-1,2	0,15-0,30	<1,0	1 300	1 200	2	7,4	50	510
MIM-4340-750H	Bal.	0,35-0,50	<0,4	<0,8	1,4-2,0	0,7-1,4	0,2-0,3	<1,0	900	750	3	7,4	25	265
MIM-4340-1300H	Bal.	0,35-0,50	<0,4	<0,8	1,4-2,0	0,7-1,4	0,2-0,3	<1,0	1 600	1 300	2	7,4	48	485
MIM-4605-1310H	Bal.	0,4-0,6	<1,0	<0,8	1,5-2,5	—	0,2-0,5	<1,0	1 480	1 310	<1	7,5	48	485
MIM-52100-1250H	Bal.	0,8-1,05	<0,4	<0,8	—	1,35-1,65	—	<1,0	1 500	1 250	1	7,4	50	510

Table 3 — Stainless steels – As-sintered

Grade	Normative values													Informative (typical) mechanical properties			Informative (typical) corrosion resistance properties		
	Chemical composition										Ultimate tensile strength min.	Yield strength (0,2 %) min.	Elongation min.	Density	Macro apparent hardness		H_2SO_4 g/dm²/day	$CuSO_4$	Boiling water
	Fe	C	Si	Mn	Ni	Cr	Mo	Cu	Nb+Ta	Others	R_m	$R_{p0,2}$	A_{25}	ρ	Rockwell	Vickers			
	%	%	%	%	%	%	%	%	%	%	MPa	MPa	%	g/cm³		HV10			
MIM-316L-140	Bal.	<0,03	<1,0	<2,0	10,0-14,0	16,0-18,5	2,0-3,0	—	—	<1,0	450	140	40	7,7	67 HRB	120	<0,005	Pass	Pass
MIM-430-210	Bal.	<0,08	<1,0	<1,5	—	16,0-18,0	—	—	—	<1,0	350	210	20	7,5	65 HRB	115	0,125	Pass	Pass
MIM-174PH-650	Bal.	<0,07	<1,0	<1,0	3,0-5,0	15,0-17,5	—	3,0-5,0	0,15-0,45	<1,0	800	650	3	7,5	27 HRC	280	<0,005	Pass	Pass

Table 4 — Stainless steels – Heat treated

Grade	Normative values													Informative (typical) mechanical properties		
	Chemical composition										Ultimate tensile strength min.	Yield strength (0,2 %) min	Elongation min.	Density	Macro-apparent hardness	
	Fe	C	Si	Mn	Ni	Cr	Mo	Cu	Nb+Ta	Others	R_m	$R_{p0,2}$	A_{25}	ρ	Rockwell	Vickers
	%	%	%	%	%	%	%	%	%	%	MPa	MPa	%	g/cm³	HRC	HV10
MIM-420-850H	Bal.	0,15-0,4	<1,0	<1,0	—	12,0-14,0	—	—	—	<1,0	1000	850	2	7,4	44	445
MIM-174PH-700H	Bal.	<0,07	<1,0	<1,0	3,0-5,0	15,0-17,5	—	3,0-5,0	0,15-0,45	<1,0	850	700	5	7,5	30	300
MIM-174PH-970H	Bal.	<0,07	<1,0	<1,0	3,0-5,0	15,0-17,5	—	3,0-5,0	0,15-0,45	<1,0	1070	970	4	7,5	33	325
MIM-174PH-1000H	Bal.	<0,07	<1,0	<1,0	3,0-5,0	15,0-17,5	—	3,0-5,0	0,15-0,45	<1,0	1200	1000	2	7,5	40	390

Table 5 — Soft-magnetic materials – As-sintered

Grade	Normative values												Informative (typical properties				
	Chemical composition												Tensiles properties				
	Fe	C	Si	Mn	Ni	Cr	Co	V	Others	Density	Maximum permeability	Magnetic induction at 1 990 A/m	Ultimate tensile strength	Yield strength (0,2 %)	Elongation	Macro-apparent hardness	
	%	%	%	%	%	%	%	%	%	ρ g/cm^3		T	R_m MPa	$R_{p0,2}$ MPa	A_{25} %	Rockwell HRC	Vickers HV10
MIM-Fe2Ni-20	Bal.	<0,1	<1,0	—	1,5-2,5	—	—	—	<1,0	7,60	2 000	1,40	290	125	40	45	87
MIM-Fe3Si-55	Bal.	<0,05	2,5-3,5	—	—	—	—	—	<1,0	7,45	5 500	1,40	530	390	24	80	150
MIM-Fe3Si-80	Bal.	<0,05	2,5-3,5	—	—	—	—	—	<1,0	7,60	8 000	1,40	530	390	24	80	150
MIM-Fe50Ni-200	Bal.	<0,05	<1,0	—	49-51	—	—	—	<1,0	7,70	20 000	1,30	455	160	30	50	93
MIM-Fe50Ni-400	Bal.	<0,05	<0,4	—	49-51	—	—	—	<1,0	7,70	40 000	1,30	455	160	30	50	93
MIM-Fe50Co-48	Bal.	<0,05	<1,0	—	—	—	48-50	<2,5	<1,0	7,70	4 800	1,90	205	140	<1	80	150
MIM-430-10	Bal.	<0,05	<1,0	<1,0	—	16,0-18,0	—	—	<1,0	7,50	1 000	1,10	415	240	25	65	115

Table 6 — Titanium – As-sintered

Grade	Normative values										Informative (typical) mechanical properties		
	Chemical composition							Ultimate tensile strength min.	Yield strength (0,2 %) min	Elongation min.	Density	Macro-apparent hardness	
	Ti	C	O	N	Al	V	Others						
	%	%	%	%	%	%	%	R_m MPa	$R_{p0,2}$ MPa	A_{25} %	ρ g/cm^3	Rockwell	Vickers HV10
MIM-Ti-400	Bal.	<0,2	<0,4	<0,1	—	—	<1,0	500	400	5	4,2	88 HRB	175
MIM-Ti6Al4V-600	Bal.	<0,2	<0,4	<0,1	5,0-7,0	3,0-5,0	<1,0	800	600	3	4,2	30 HRC	300

Bibliography

[1] ISO 5755, *Sintered metal materials — Specifications*

[2] ASTM F1089, *Standard Test Method for Corrosion of Surgical Instruments*

[3] MPIF Standard Test Method 62, Determination of the Corrosion Resistance of MIM Grades of Stainless Steel Immersed in 2 % Sulfuric Acid Solution

ICS 77.160

Price based on 11 pages

This page deliberately left blank

British Standards Institution (BSI)

BSI is the independent national body responsible for preparing British Standards and other standards-related publications, information and services. It presents the UK view on standards in Europe and at the international level.

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

Revisions

British Standards and PASs are periodically updated by amendment or revision. Users of British Standards and PASs 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 British Standards would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Similary for PASs, please notify BSI Customer Services.

Tel: +44 (0)20 8996 9001 Fax: +44 (0)20 8996 7001

BSI offers BSI Subscribing Members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of British Standards and PASs.

Tel: +44 (0)20 8996 7669 Fax: +44 (0)20 8996 7001
Email: plus@bsigroup.com

Buying standards

You may buy PDF and hard copy versions of standards directly using a credit card from the BSI Shop on the website **www.bsigroup.com/shop.** In addition all orders for BSI, international and foreign standards publications can be addressed to BSI Customer Services.

Tel: +44 (0)20 8996 9001 Fax: +44 (0)20 8996 7001
Email: orders@bsigroup.com

In response to orders for international standards, BSI will supply the British Standard implementation of the relevant international standard, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Knowledge Centre.

Tel: +44 (0)20 8996 7004 Fax: +44 (0)20 8996 7005
Email: knowledgecentre@bsigroup.com

BSI Subscribing Members 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: +44 (0)20 8996 7002 Fax: +44 (0)20 8996 7001
Email: membership@bsigroup.com

Information regarding online access to British Standards and PASs via British Standards Online can be found at **www.bsigroup.com/BSOL**

Further information about British Standards is available on the BSI website at **www.bsi-group.com/standards**

Copyright

Tel: +44 (0)20 8996 7070
Email: copyright@bsigroup.com

BSI

389 Chiswick High Road London W4 4AL UK

Tel +44 (0)20 8996 9001
Fax +44 (0)20 8996 7001
www.bsigroup.com/standards

raising standards worldwide™