British Standard

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BRITISH STANDARD

BS 3468:1986

Specification for

Austenitic cast iron

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Committees responsible for this British Standard

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

BCIRA
British Engine Group of SMMT
British Foundry Association
British Gear Manufacturers Association
British Malleable Tube Fittings Association
British Steel Industry
British Valve Manufacturers Association Ltd.
Energy Industries Council
Institution of Mechanical Engineers
Meehanite Institute of Great Britain
Metal Trades Organizations
National Association of Malleable Ironfounders
Society of Motor Manufacturers and Traders Limited

The following bodies were also represented in the drafting of the standard, through sub-committees and panels:

BEAMA Ltd.
British Pump Manufacturers' Association
Institute of British Foundrymen

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Amd. No.	Date	Comments

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Foreword

This British Standard has been prepared under the direction of the Iron and Steel Standards Committee and is a revision of BS 3468:1974 which is withdrawn.

ISO 2892, published by the International Organization for Standardization (ISO), was taken into account in the preparation of BS 3468:1974.

This standard is a major revision of BS 3468:1974. The principal changes are:

a) The number of grades specified has been reduced from 20 to 11. There are now three grades of flake graphite and eight grades of spheroidal graphite material compared with 9 and 11 grades respectively in the previous edition.

b) The grades are presented in two groups, the first being engineering grades suitable for corrosion and heat resisting applications and the second special purposes grades for applications such as cryogenic service, low magnetic permeability or use of other specific property.

c) The designation of the grades has been altered from a graphite structure letter followed by chemical symbols and figures, indicating alloy elements and their approximate mean levels, to a graphite structure letter followed by a single sequential grade number.

d) Three of the engineering grades and all the special purpose grades specified approximate to grades in BS 3468:1974. Grade S2W is a new grade with improved weldability and grade S5S is a new grade with resistance to growth and scaling up to 850 °C and good thermal shock resistance.

e) In BS 3468:1974 the impact properties of some grades of spheroidal graphite material were specified as a mandatory requirement. The revised standard provides the option that impact testing will only be carried out if the purchaser specifies this requirement at the time of the enquiry and order.

Additions to the revised standard define the number of test samples in relation to the quantity of castings produced, and define in greater detail procedures for retests. New appendices give guidance on heat treatment for stress relief and high temperature stability and provide information about the new material grade with improved weldability.

Austenitic cast irons are high alloy materials in which the metallic matrix has been rendered austenitic at ambient temperatures by the use of alloying elements and in which the carbon is present predominantly as either flake or spheroidal graphite. Eutectic carbides are often also present, particularly in the high chromium grades. The method of producing austenitic cast iron is left to the discretion of the manufacturer.

Spheroidal graphite grades of austenitic cast iron have mechanical properties superior to those of the flake graphite types. Generally they exhibit superior resistance to heat and corrosion and have other physical properties which differ from those of the flake graphite types of similar basic chemical composition.

Appendix A covers supplementary data on typical mechanical and physical properties of austenitic cast iron (for information only).

Appendix B compares grades in this edition with those of BS 3468:1974 and other national and international (ISO) standards.

Appendix C covers heat treatment of austenitic iron castings.

Appendix D covers austenitic iron with improved weldability.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 12, 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.

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1 Scope

This British Standard specifies requirements for the chemical composition and mechanical properties of eleven grades of austenitic cast iron intended for use in the manufacture of castings. Three of these grades are of the flake graphite type and the remaining eight are of the spheroidal or nodular graphite type. These grades are presented in two groups, the first including general engineering grades suitable for corrosion and heat resisting applications and the second including special purpose grades for such applications as cryogenic service, low magnetic permeability or other specific property.

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

2 Designation

Each grade having a microstructure of flake graphite shall be designated by the capital letter "F" and a single sequential grade number e.g. "grade F3".

Each grade having a microstructure of spheroidal or nodular graphite shall be designated by the capital letter "S" followed by a single sequential grade number e.g. "grade S3".

3 Information to be supplied by the purchaser

3.1 General

The following information to be supplied by the purchaser shall be fully documented:

a) the number and date of this British Standard, i.e. "BS 3468:1986";

b) the grade of material required, e.g. "grade S3".

3.2 Options

There is an option on impact testing spheroidal graphite grades S2B, S2C and S2M incorporated in this British Standard. In the event that the purchaser does not indicate his wish to implement this option and specify his requirements at the time of enquiry and order, the manufacturer shall assume that no impact testing is required for these grades (see **4.2.2**).

4 Chemical composition and mechanical properties

4.1 Chemical composition

When tested in accordance with **7.1**, the chemical composition of the grades of austenitic cast iron shall be as given in Table 1 in the case of material of engineering grades and Table 2 for material for special purposes.

Alloying elements other than those in Table 1 and Table 2 may be present in the composition, at the discretion of the manufacturer, providing they do not alter the microstructure or properties specified in this British Standard.

4.2 Mechanical properties

4.2.1 *Tensile properties.* When tested in accordance with **7.2**, the tensile properties of the grades of austenitic cast iron shall be as given in Table 1 or Table 2.

4.2.2 *Impact properties.* In the case of spheroidal graphite grades of austenitic cast iron S2B, S2C and S2M, the material shall be supplied with either:

a) no impact testing (see **3.2**); or

b) Charpy V-notch impact testing (see **7.3**), to meet the minimum impact strength values given in Table 2.

5 Sampling and number of test samples

5.1 Mass of a batch

For the purposes of testing material that is representative of a batch of castings, a batch shall be defined as being the castings poured from the same ladle of metal and, where applicable, which have been submitted to the same heat treatment. The maximum mass of one batch shall not exceed 4 000 kg of molten metal, but a single casting shall constitute a batch if its mass is equal to or greater than 2 000 kg.

In the case of continuous production of large tonnages the maximum mass of a batch may be increased but shall not exceed the tonnage produced by the melting or holding facility concerned in 1 h.

5.2 Sampling

One tensile test and, when required (see **4.2.2**), three tests for the determination of impact strength shall be carried out either:

a) for each batch; or

b) in the case of continuous production, for each batch or for several batches grouped together provided the manufacturer confirms by metallographic examination or by the use of non-destructive testing techniques that successive treatments have been carried out successfully and under the same conditions.

NOTE The impact test is applicable only to grades S2B, S2C and S2M.

6 Test samples and test pieces

6.1 Test samples (often called keel blocks) shall be poured at the same time as the castings that they represent. A number of test samples shall be poured from the same ladle of metal as that used to produce the castings that they represent in accordance with clause **5**.

The test samples shall be poured separately and cast in sand moulds.

The thickness of the sand mould surrounding the test sample during casting shall be 40 mm minimum.

6.2 In cases where heat treatment is necessary, the test samples shall be heat treated with the castings that they represent.

6.3 The test pieces, representative of spheroidal graphite grades used for the tests specified in clause **7**, shall be taken either from the keel of the "U" type test sample (i.e. the hatched section in Figure 1), the "Y" type test sample (see Figure 2) or the "knock off" type test sample (see Figure 3) prepared in accordance with **6.1** and machined in accordance with Figure 4.

6.4 The test pieces, representative of the flake graphite grades used for the tests specified in clause **7** shall be prepared in accordance with **6.1** and **6.3** or prepared from a separately cast round test bar sample of 25 mm diameter machined in accordance with Figure 4.

7 Testing

7.1 Chemical analysis

The chemical composition of the material shall be determined. Analysis shall be carried out on a test sample made from the same melt as the castings represented. Cases of disputed compliance with this standard shall be decided by an independent analysis using the methods specified in BS Handbook No. 19.

7.2 Tensile test

The tensile test shall be carried out in accordance with BS 18-2 on either:

a) a 14 mm diameter proportional test piece, as shown in Figure 4; or

b) if it is necessary to use a test piece having a different diameter, on a test piece whose dimensions shall be in accordance with the following ratio:

$L_o = 5.65 \sqrt{S_o}$

where

L_o is the original gauge length;

S_o is the original cross-sectional area of the test piece.

7.3 Impact test

Spheroidal graphite grades shall be subjected to impact testing when the option to do so in **4.2** is invoked by the purchaser. Testing shall be carried out on a V-notch (Charpy) test piece in accordance with BS 131-2 at an ambient temperature of 20 ± 5 °C.

8 Retests

8.1 If a test piece fails any of the tests specified in clause **7** due to one of the following reasons and not due to the quality of the cast iron, the results shall be discarded.

a) Faulty mounting of the test piece or defective operation of the test machine.

b) Defective test sample or machining of the test piece.

c) Fracture of the tensile test piece beyond the gauge marks.

d) Casting defects in the test piece, evident after fracture.

In these cases, a new test piece shall be taken from the same test sample and the results obtained substituted for those of the defective test piece.

8.2 If, after testing, the mechanical properties are not as given in Table 1 or Table 2, one of the following procedures shall be carried out. Either:

a) repeat the relevant mechanical test on two additional test pieces; or

b) re-heat treat the test pieces together with the castings represented and resubmit for testing.

NOTE In cases where insufficient test material is available, smaller tensile test pieces than indicated in **7.2** can be used, provided the ratio $L_o = 5.65 \sqrt{S_o}$ is maintained.

A batch shall be deemed to comply with the requirements of this British Standard when the results of two retests are in accordance with **4.2**. However, the batch shall be deemed not to comply if one of the new test pieces fails.

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Table 1 — Chemical composition and mechanical properties of austenitic cast iron: general engineering grades

Type	Grade	C max.	Si	Mn	Ni	Cu	Cr	Nb	P max.	Mg[a]	Tensile strength min. (R_m)	0.2 % Proof stress, min. ($R_{p\,0.2}$)	Elongation min. *(A)*
		%	%	%	%	%	%	%	%	%	N/mm^2 [b]	N/mm^2 [b]	%
Flake Graphite	F1	3.0	1.5 to 2.8	0.5 to 1.5	13.5 to 17.5	5.5 to 7.5	1.0 to 2.5	—	0.2	—	170	—	—
	F2	3.0	1.5 to 2.8	0.5 to 1.5	18.0 to 22.0	0.5 max.	1.5 to 2.5	—	0.2	—	170	—	—
Spheroidal Graphite	S2	3.0	1.5 to 2.8	0.5 to 1.5	18.0 to 22.0	0.5 max.	1.5 to 2.5	—	0.08	—	370	210	7
	S2W[c]	3.0	1.5 to 2.2	0.5 to 1.5	18.0 to 22.0	0.5 max.	1.5 to 2.2	0.12 to 0.2	0.05	0.06[a] max.	370	210	7
	S5S	2.2	4.8 to 5.4	1.0 max.	34.0 to 36.0	0.5 max.	1.5 to 2.5	—	0.08	—	370	210	7

NOTE 1 See Appendix A for typical properties and applications of the grades.

NOTE 2 See Appendix B for comparison with previous editions, grades and other national and international standards.

[a] Magnesium is always an added element in S grades, but the level is not specified except in the case of grade S2W.

[b] 1 N/mm^2 = 1 MPa.

[c] See Appendix D for details of the improved weldability of this grade.

Table 2 — Chemical composition and mechanical properties of austenitic cast iron: special purpose grades

Type	Grade	C max.	Si	Mn	Ni	Cu max.	Cr	P max.	Tensile strength min. (R_m)	0.2 % Proof stress, min. ($R_{p\,0.2}$)	Elongation min. *(A)*	Charpy V-notch impact strength min. at ambient temperature 20 ± 5 °C[a]
		%	%	%	%	%	%	%	N/mm^2 [b]	N/mm^2 [b]	%	J
Flake graphite	F3	2.5	1.5 to 2.8	0.5 to 1.5	28 to 32	0.5	2.5 to 3.5	0.2	190	—		
Spheroidal graphite	S2B	3.0	1.5 to 2.8	0.5 to 1.5	18 to 22	0.5	2.5 to 3.5	0.08	370	210	7	4
	S2C	3.0	1.5 to 2.8	1.5 to 2.5	21 to 24	0.5	0.5 max.	0.08	370	170	20	20
	S2M[c]	3.0	1.5 to 2.5	4.0 to 4.5	21 to 24	0.5	0.2 max.	0.08	420	200	25	15
	S3	2.5	1.5 to 2.8	0.5 to 1.5	28 to 32	0.5	2.5 to 3.5	0.08	370	210	7	
	S6	3.0	1.5 to 2.8	6.0 to 7.0	12 to 14	0.5	0.2 max.	0.08	390	200	15	

NOTE 1 See Appendix A for typical properties and applications of these grades.
NOTE 2 See Appendix B for comparison with previous editions, grades and other national and international standards.

[a] The Charpy V-notch impact strength is specified only in cases where the purchaser invokes the option (see **3.2** and **4.2.2**).

[b] 1 N/mm^2 = 1 MPa.

[c] Ambient temperature mechanical properties of grade S2M are maintained down to – 150 °C.

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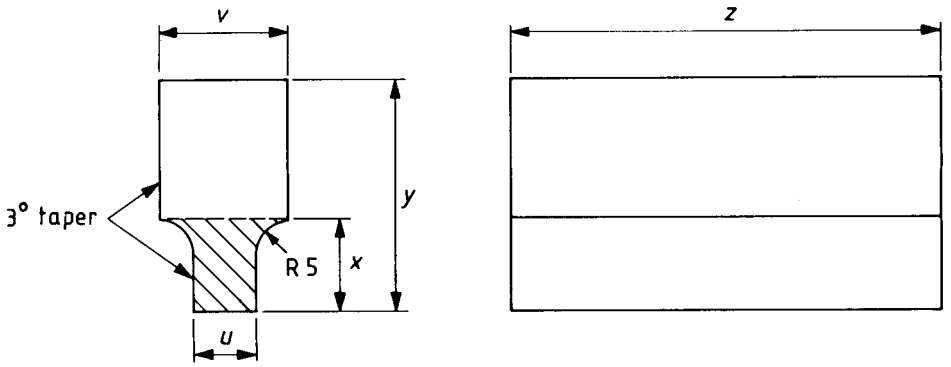
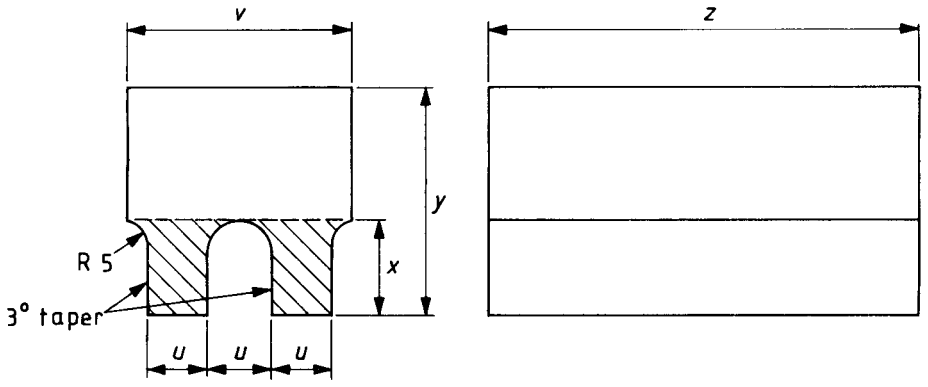


(a)



(b)

Figure key letter	Dimension	
	Figure 1(a)	Figure 1(b)
	mm	mm
u	25	25
v	55	90
x	40	40
y	100	100
z	A function of the test piece length	

NOTE The thickness of the sand mould surrounding the test sample during casting to be 40 mm minimum.

Figure 1 — "U" type test sample

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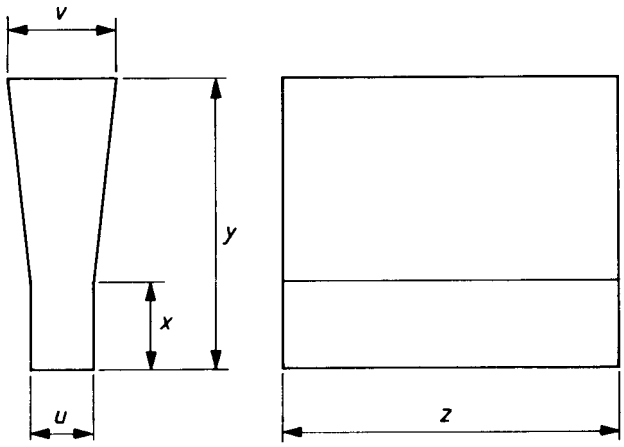

Figure key letter	Dimension
	mm
u	25
v	55
x	40
y	140
z	A function of the test piece length

NOTE The thickness of the sand mould surrounding the test sample during casting to be 40 mm minimum.

Figure 2 — "Y" type test sample

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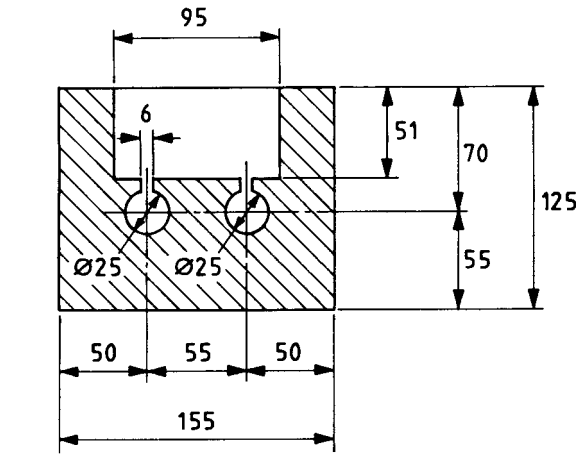
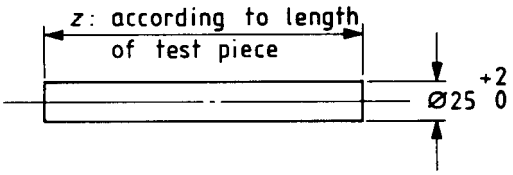


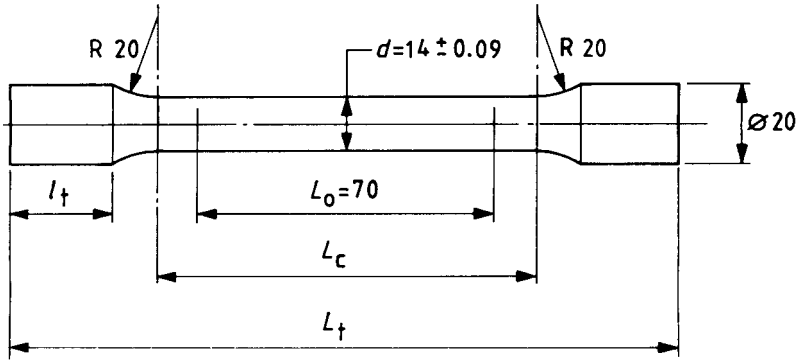
(a) Mould



(b) As-cast test sample

All dimensions are in millimetres.

Figure 3 — "Knock-off" type test samples



NOTE The method of gripping the ends of the test pieces, together with their length, l_t, may be agreed between the manufacturer and purchaser.
L_o is the original gauge length; in this instance $L_o = 5d$;
d is the original diameter of the test piece;
L_c is the parallel length;
L_t is the total length of the test piece.
all dimensions are in millimetres.

Figure 4 — Tensile test piece

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Appendix A Supplementary data on mechanical and physical properties of austenitic cast iron

A.1 General

All grades of austenitic cast iron have a good resistance to heat and corrosion. Other properties including thermal expansion, magnetic permeability, impact value at low temperature and erosion resistance relate to the individual grades of austenitic cast iron.

In determining the physical properties of austenitic cast iron, it should be noted that the casting skin does not in general exhibit the same properties as the base material. This is particularly relevant when testing electrical and magnetic properties and therefore, before any such measurement is made, the casting skin has to be carefully removed. The surface of the material should not be subjected to mechanical stresses sufficient to cause plastic flow during this operation, as it would once again differ from the base metal. Therefore the best test procedures are those in which the property to be measured is determined over a test piece volume that is not too small.

It is recommended that a round test piece, about 10 mm in diameter and 100 mm in length, should be carefully machined (low depth and speed of cut) from a test sample cast at the same time as the casting. The test piece should then be carefully pickled as traces of deformation martensite or ferromagnetic tool particles adhering to the surface tend to give incorrect measurements.

A.2 Engineering grades (for corrosion and heat resisting applications)

Typical mechanical and physical properties of each of the engineering grades of austenitic cast iron are given in Table 3 and Table 4.

Characteristics and typical applications of the engineering grades are given in Table 7.

A.3 Special purpose grades

Typical mechanical and physical properties of each of the special purpose grades of austenitic cast iron are given in Table 5 and Table 6.

Characteristics and typical applications of the special purpose grades are given in Table 8.

Table 3 — Typical mechanical properties of engineering grades of austenitic cast iron

Grade	Tensile strength (R_m)	0.2 % Proof stress ($R_{p\,0.2}$)	Elongation[a] (A)	Elastic modulus (E)	Brinell hardness	Charpy V-notch[a] impact strength at ambient temperature
	N/mm^2	N/mm^2	%	GN/m^2	HB	J
F1	170 to 240	—	1 to 2	85 to 113	140 to 220	
F2	170 to 240	—	1 to 3	85 to 113	140 to 220	
S2	370 to 490	210 to 260	7 to 20	112 to 133	140 to 230	4 to 20
S2W	370 to 490	210 to 260	7 to 20	112 to 133	140 to 200	10 to 20
S5S	370 to 470	210 to 260	7 to 20	92 to 120	130 to 180	

[a] Depends on chromium content specified.

Table 4 — Typical physical properties of engineering grades of austenitic cast iron

Grade	Nominal density	Thermal coefficient of expansion (20 °C to 200 °C)	Thermal conductivity	Magnetic permeability (μ)
	Mg/m^3	$10^{-6}/K$	W/(m·K)	H/m
F1	7.3	18.7	38 to 42	1.3
F2	7.3	18.7	38 to 42	1.3
S2	7.4	18.7	12.6	1.3
S2W	7.4	18.7	12.6	1.3
S5S	7.6	12.1	12.6	Magnetic

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Table 5 — Typical mechanical properties of special purpose grades of austenitic cast iron

Grade	Tensile strength (R_m)	0.2 % Proof stress ($R_{p\,0.2}$)	Elongation[a] (A)	Elastic modulus (E)	Brinell hardness	Charpy V-notch[a] impact strength at ambient temperature
	N/mm^2	N/mm^2	%	GN/m^2	HB	J
F3	190 to 240	—	1 to 3	98 to 113	120 to 215	—
S2B	370 to 490	210 to 260	7 to 20	112 to 133	140 to 230	4 to 10
S2C	370 to 440	170 to 250	20 to 40	85 to 112	130 to 170	20 to 30
S2M	420 to 470	210 to 240	25 to 45	120 to 140	150 to 180	15 to 25
S3	370 to 470	210 to 260	7 to 18	92 to 130	130 to 200	4 to 20
S6	390 to 460	200 to 260	15 to 25	140 to 150	130 to 170	15 to 25

[a] Depends on chromium content specified.

Table 6 — Typical physical properties of special purpose grades of austenitic cast iron

Grade	Nominal density	Thermal coefficient of expansion (20 °C to 200 °C)	Thermal conductivity	Magnetic permeability (μ)
	Mg/m^3	$10^{-6}/K$	W/(m·K)	H/m
F3	7.3	12.4	38 to 42	Magnetic
S2B	7.4	18.7	12.6	1.3
S2C	7.4	18.4	12.6	1.03
S2M	7.4	14.7	12.6	1.03
S3	7.4	12.6	12.6	Magnetic
S6	7.3	18.2	12.6	1.02

Table 7 — Properties and typical applications of flake graphite and spheroidal graphite austenitic cast iron: general engineering grades

Grade	Properties	Typical applications
F1	Flake graphite. Good resistance to corrosion, particularly in alkalis, dilute acids, sea water and salt solutions. Good heat resistance, good bearing properties, high thermal expansion. A chromium level of 1.75 % to 2.25 % provides optimum corrosion and erosion resistance combined with good founding characteristics	Pumps, valves, furnace components, bushings, piston ring carriers for light alloy metal pistons
F2	Flake graphite. Similar to grade F1 but more corrosion resistant to alkalis. High coefficient of thermal expansion	As for grade F1 but preferably for pumps handling alkalis, vessels for caustic service uses, in soap, food, plastics. Suitable where copper-free materials are required
S2 and S2W	Spheroidal graphite. Similar to grade F2 for composition, corrosion and heat resistance but with superior mechanical properties. Comments regarding chromium content apply (see Table 3 and Table 5) Grade S2W has improved weldability (provided that an approved welding procedure is agreed) (see Appendix D)	Pumps, valves, compressors, bushings, turbo-supercharger housings, exhaust gas manifolds operating up to 750 °C
S5S	Spheroidal graphite. Excellent resistance to growth and scaling up to 850 °C. Lower coefficient of thermal expansion than other grades and good thermal shock resistance	Parts for gas turbines, including housings, support rings. Turbo-charger housings and exhaust gas manifolds. Die blocks for titanium pressings

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Table 8 — Properties and typical applications of austenitic cast iron: special purpose grades

Grade	Properties	Typical applications
F3	Flake graphite. Resistance to heat and thermal shock up to 800 °C. Good corrosion resistance at high temperature, excellent erosion resistance in wet steam and salt slurry. Average thermal expansion	Pumps, valves, filter parts, exhaust gas manifolds and turbocharger housings
S2B	Spheroidal graphite. Similar to S2 in relation to properties but a chromium level of 2.5 % to 3.5 % provides superior corrosion and erosion resistance at an increased risk of porosity in complex castings	Pumps, valves, compressors, bushings, turbo-supercharger housings, exhaust gas manifolds operating up to 750 °C
S2C	Spheroidal graphite. High coefficient of thermal expansion. Lower corrosion and heat resistance than grade S1. Good impact properties down to – 100 °C. Non-magnetic with permeability of 1.03 to 1.05	Non-magnetic components in electric generator sets, housings for insulator flanges, etc., non-magnetic components requiring controlled low magnetic permeability, moderate cryogenic service
S2M	Spheroidal graphite. Ambient mechanical properties maintained to – 150 °C. Non-magnetic	Castings for refrigeration, engineering for use down to liquid nitrogen temperature
S3	Spheroidal graphite. Similar to grade F3 with superior mechanical properties	Similar to grade F3
S6	Spheroidal graphite. Non-magnetic	Pressure covers for turbine generator sets, housings for switchgear insulator flanges, terminals and ducts

Appendix B Comparison of grades in this edition of BS 3468 with those of the previous edition (1974) and other national and international (ISO) standards

Table 9 — Designation and grades of austenitic cast iron corresponding to engineering grades

British Standard BS 3468:1986	British Standard 3468:1974 and ISO 2892:1973	France NFA 32–301	Fed. R. Germany DIN 1694	USA ASTM A436 ASTM A439	Sweden SIS
F1	L–NiCuCr 15 6 2	L–NUC 15 6 2	GGL–NiCuCr 15 6 2	A436 type 1 and 1B	
	L–NiCuCr 15 6 3	L–NUC 15 6 3	GGL–NiCuCr 15 6 3		
F2	L–NiCr 20 2	L–NC 20 2	GGL–NiCr 20 2	A436 type 2	14.05.23
	L–NiCr 20 3	L–NC 20 3	GGL–NiCr 20 3		
S2	S–NiCr 20 2	S–NC 20 2	GGG–NiCr 20 2	A439 type	14.07.72
	S–NiCr 20 3	S–NC 20 3	GGG–NiCr 20 3	D-2	
S2W	—	—	GGG–NiCrNb 20 2	—	
S5S	—	—	GGG–NiSiCr 35/5/2	A439 type D-55	

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Table 10 — Designation and grades of austenitic cast iron corresponding to special purpose grades

British Standard BS 3468:1986	British Standard 3468:1974 and and ISO 2892:1973	France NFA 32–301	Fed. R. Germany DIN 1694:1977	USA ASTM A436 ASTM A439
F3	L–NiCr 30 3	L–NC 30 3	GGL–NiCr 30 3	A436 type 3
S2B	S–NiCr 20 3	S–NC 20 3	GGG–NiCr 20 3	A439 type D–2B
S2C	S–Ni 22	S–N 22	GGG–Ni 22	A439 type D–2C
S2M	S–NiMn 23 4	S–NM 234	GGG–NiMn 23–4	A571 type D–2M
S3	S–NiCr 30 1 S–NiCr 30 3	S–NC 30 1 S–NC 30 3	GGG–NiCr 30 1 GGG–NiCr 30 3	A439 type D–3
S6	S–NiMn 13 7	S–NM 13 7	GGG–NiMn 13 7	—

Appendix C Heat treatment

C.1 General

For certain applications heat treatment of austenitic iron castings is beneficial, but should only be specified where conditions in service demand such treatment.

C.2 Stress relief

C.2.1 Stress relief can be applied to all grades of austenitic cast iron, but is specifically recommended under the following conditions:

a) where the casting is of such complexity that excessive residual casting stresses can be expected which could lead to dimensional change during machining or in service;

b) where complex castings are intended for operation under conditions where stress corrosion cracking might otherwise occur: for example when handling hot saline or highly alkaline solutions.

It may be advantageous to carry out stress relieving after rough machining.

C.2.2 The recommended stress relief heat treatment is as follows:

a) Heat to between 625 °C and 650 °C at a rate not exceeding 150 °C/h.

b) Hold at this temperature for 2 h plus 1 h per 25 mm section.

c) Furnace cool at a rate not exceeding 100 °C/h to 200 °C, air cool.

C.3 Heat treatment for high temperature stability

Austenitic iron castings used for static or cyclic elevated temperature service at 500 °C or above, where it is essential that close dimensional tolerances are held, should be given a structural stabilizing treatment. Typical examples are exhaust manifolds and turbo-charger components.

The recommended treatment is as follows.

a) Heat to between 875 °C and 900 °C at a rate not exceeding 150 °C/h.

b) Hold at this temperature for 2 h plus 1 h per 25 mm section.

c) Furnace cool to 500 °C at a rate not exceeding 50 °C/h, air cool.

For certain critical components, this treatment can be followed by a stress relief after rough machining. It should be noted that the copper containing austenitic iron grade F1 is not amenable to the high temperature structural stabilizing treatment.

Appendix D Austenitic iron grade S2W: austenitic iron with improved weldability

The satisfactory welding of spheroidal graphite grades of austenitic iron is difficult to control. However, the development of grade S2W, subject to close compositional control and the addition of niobium, has led to satisfactory casting weld repair and limited fabrication operations.

Details of weld practice are available from established producers of austenitic iron and they will submit weld procedures to customers and users of castings on request, detailing weld preparation, welding technique, approved welding consumables and any heat treatment required.

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Publications referred to

BS 18, *Methods for tensile testing of metals.*
BS 18-2, *Steel (general).*
BS 131, *Methods for notched bar tests.*
BS 131-2, *The Charpy V-notch impact test on metals.*
BS 240, *Method for Brinell hardness test.*
BS 240-1, *Testing of metals.*
Handbook No. 19 Methods for the sampling and analysis of iron, steel and other ferrous metals.

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