



Founding  
Spheroidal graphite cast iron  
English version of DIN EN 1563

**DIN**  
EN 1563

ICS 77.080.10

Descriptors: Spheroidal graphite cast iron.

Gießereiwesen – Gußeisen mit Kugelgraphit

Supersedes DIN 1693-1,  
October 1973 edition, and  
DIN 1693-2, October 1977  
edition.

**European Standard EN 1563:1997 has the status of a DIN Standard.**

*A comma is used as the decimal marker.*

### National foreword

This standard has been prepared by CEN/TC 190.

The responsible German body involved in its preparation was the *Normenausschuß Gießereiwesen* (Foundry Practice Standards Committee), Technical Committee *Gußeisen mit Kugelgraphit*.

For ease of reference, a National Annex is provided overleaf in which the material grades specified in this standard are correlated with those previously used in Germany.

### Amendments

DIN 1693-1, October 1973 edition, and DIN 1693-2, October 1977 edition, have been superseded by the specifications of EN 1563.

32 new grades have been included, the method of hardness testing has been changed.

### Previous editions

DIN 1693: 1961-09; DIN 1693-1: 1973-10; DIN 1693-2: 1977-10.

Continued overleaf.  
EN comprises 24 pages.

Bearbeitet: **Normung**

**4.02.02**

### National Annex NA

List of spheroidal graphite cast iron grades used in this standard correlated with those used previously in DIN 1693-1 and DIN 1693-2

Designation as in DIN 1693-1/DIN 1693-2		Designation as in DIN EN 1563	
Symbol	Material number	Symbol	Material number
<b>Separately cast samples</b>			
GGG-35.3	0.7033	EN-GJS-350-22-LT	EN-JS1015
—	—	EN-GJS-350-22-RT	EN-JS1014
—	—	EN-GJS-350-22	EN-JS1010
GGG-40.3	0.7043	EN-GJS-400-18-LT	EN-JS1025
—	—	EN-GJS-400-18-RT	EN-JS1024
—	—	EN-GJS-400-18	EN-JS1020
GGG-40	0.7040	EN-GJS-400-15	EN-JS1030
—	—	EN-GJS-450-10	EN-JS1040
GGG-50	0.7050	EN-GJS-500-7	EN-JS1050
GGG-60	0.7060	EN-GJS-600-3	EN-JS1060
GGG-70	0.7070	EN-GJS-700-2	EN-JS1070
GGG-80	0.7080	EN-GJS-800-2	EN-JS1080
—	—	EN-GJS-900-2	EN-JS1090
<b>Cast-on samples</b>			
—	—	EN-GJS-350-22U-LT	EN-JS1019
—	—	EN-GJS-350-22U-RT	EN-JS1029
—	—	EN-GJS-350-22U	EN-JS1032
GGG-40.3	0.7043	EN-GJS-400-18U-LT	EN-JS1049
—	—	EN-GJS-400-18U-RT	EN-JS1059
—	—	EN-GJS-400-18U	EN-JS1062
GGG-40	0.7040	EN-GJS-400-15U	EN-JS1072
—	—	EN-GJS-450-10U	EN-JS1132
GGG-50	0.7050	EN-GJS-500-7U	EN-JS1082
GGG-60	0.7060	EN-GJS-600-3U	EN-JS1092
GGG-70	0.7070	EN-GJS-700-2U	EN-JS1102
—	—	EN-GJS-800-2U	EN-JS1112
—	—	EN-GJS-900-2U	EN-JS1122
<b>Grades based on hardness</b>			
—	—	EN-GJS-HB130	EN-JS2010
—	—	EN-GJS-HB150	EN-JS2020
—	—	EN-GJS-HB155	EN-JS2030
—	—	EN-GJS-HB185	EN-JS2040
—	—	EN-GJS-HB200	EN-JS2050
—	—	EN-GJS-HB230	EN-JS2060
—	—	EN-GJS-HB265	EN-JS2070
—	—	EN-GJS-HB300	EN-JS2080
—	—	EN-GJS-HB330	EN-JS2090

ICS 77.140.80

Descriptors: Spheroidal graphite cast iron.

**English version**

Founding

**Spheroidal graphite cast iron**

Fonderie – Fonte à graphite sphéroïdal      Gießereiwesen – Gußeisen mit Kugelgraphit

This European Standard was approved by CEN on 1997-05-02.

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 Central Secretariat or to any CEN member.

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**CEN**

European Committee for Standardization  
Comité Européen de Normalisation  
Europäisches Komitee für Normung

**Central Secretariat: rue de Stassart 36, B-1050 Brussels**

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### Foreword

This European Standard has been prepared by Technical Committee CEN/TC 190 "Foundry technology", the secretariat of which is held by DIN.

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 1997, and conflicting national standards shall be withdrawn at the latest by December 1997.

Within its programme of work, Technical Committee CEN/TC 190 requested CEN/TC 190/WG 2.30 "Spheroidal graphite and austempered ductile iron" to prepare the following standard:

EN 1563

Founding – Spheroidal graphite cast irons

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

## **Introduction**

This European Standard deals with the classification of spheroidal graphite cast iron in accordance with the mechanical properties of the material.

The properties of spheroidal graphite cast iron depend on its structure.

The mechanical properties of the material can be evaluated on machined test pieces prepared from:

- separately cast samples;
- samples cast onto either the casting or the running system, hereafter referred to as cast-on sample;
- samples cut from a casting (only when an agreement is made between the manufacturer and the purchaser).

The grade of the material is defined from the mechanical properties measured on machined test pieces prepared from separately cast samples.

If hardness is a requirement of the purchaser as being important for the application, then annex A provides means for its determination.

Further technical data on spheroidal graphite cast iron are given in annex B.

## **1 Scope**

This European Standard defines the grades and the corresponding requirements of spheroidal graphite cast irons.

This European Standard specifies a classification based on mechanical properties measured on machined test pieces prepared from:

- separately cast samples;
- cast-on samples;
- samples cut from a casting.

This standard also specifies a classification as a function of hardness.

This standard does not cover technical delivery conditions for spheroidal graphite iron castings, see EN 1559-1 and EN 1559-3.

This standard does not apply to spheroidal graphite cast iron used for pipes, fittings and accessories which are the subject of EN 545, EN 598, EN 969 and ISO 2531.

## 2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 10002-1

Metallic materials – Tensile testing – Part 1: Method of test (at ambient temperature)

EN 10003-1

Metallic materials – Brinell hardness test – Part 1: Test method

EN 10045-1

Metallic materials – Charpy impact test – Part 1: Test method

EN ISO 945 : 1994

Cast iron – Designation of microstructure of graphite (ISO 945 : 1975)

NOTE: Informative references to documents used in the preparation of this standard, and cited at the appropriate places in the text, are listed in a bibliography, see annex C.

## 3 Definitions

For the purposes of this standard, the following definitions apply:

### 3.1 spheroidal graphite cast iron

Cast material, iron and carbon based, the latter element being present mainly in the form of spheroidal graphite particles.

NOTE: Spheroidal graphite cast iron is also known as ductile iron.

### 3.2 graphite spheroidizing treatment

Treatment which brings the liquid iron into contact with a substance to produce graphite in the spheroidal form during solidification.

## **4 Designation**

The material shall be designated either by symbol or by number as given in tables 1 to 4.

## **5 Order information**

The following information shall be supplied by the purchaser:

- a) the number of this European Standard (EN 1563);
- b) the designation of the material;
- c) any special requirements which have to be agreed by the time of acceptance of the order.

## **6 Manufacture**

The method of manufacturing of spheroidal graphite cast iron as well as its chemical composition and any heat treatment, unless specified by the purchaser, shall be left to the discretion of the manufacturer.

All agreements between the manufacturer and the purchaser shall be made by the time of the acceptance of the order.

## **7 Requirements**

### **7.1 Test pieces machined from separately cast samples**

#### **7.1.1 General**

The mechanical properties of spheroidal graphite cast iron shall be as specified in tables 1 and 2, and, if applicable, in accordance with the requirements given in 7.1.2.

#### **7.1.2 Impact test**

The particular impact resistance values given in table 2 for room and low temperature applications, if applicable, shall only be determined if specified by the purchaser by the time of acceptance of the order.

**Table 1: Mechanical properties measured on test pieces machined from separately cast samples**

Material designation		Tensile strength $R_m$ N/mm <sup>2</sup>	0,2% proof stress $R_{p0.2}$ N/mm <sup>2</sup>	Elongation $A$ %
Symbol	Number	min.	min.	min.
EN-GJS-350-22-LT <sup>1)</sup>	EN-JS1015	350	220	22
EN-GJS-350-22-RT <sup>2)</sup>	EN-JS1014	350	220	22
EN-GJS-350-22	EN-JS1010	350	220	22
EN-GJS-400-18-LT <sup>1)</sup>	EN-JS1025	400	240	18
EN-GJS-400-18-RT <sup>2)</sup>	EN-JS1024	400	250	18
EN-GJS-400-18	EN-JS1020	400	250	18
EN-GJS-400-15	EN-JS1030	400	250	15
EN-GJS-450-10	EN-JS1040	450	310	10
EN-GJS-500-7	EN-JS1050	500	320	7
EN-GJS-600-3	EN-JS1060	600	370	3
EN-GJS-700-2	EN-JS1070	700	420	2
EN-GJS-800-2	EN-JS1080	800	480	2
EN-GJS-900-2	EN-JS1090	900	600	2

<sup>1)</sup> LT for low temperature

<sup>2)</sup> RT for room temperature

**NOTE 1:** The values for these materials apply to castings cast in sand moulds of comparable thermal diffusivity. Subject to amendments to be agreed upon in the order, they can apply to castings obtained by alternative methods.

**NOTE 2:** Whatever the method used for obtaining the castings, the grades are based on the mechanical properties measured on test pieces taken from samples separately cast in a sand mould or a mould of comparable thermal diffusivity.

**NOTE 3:** 1 N/mm<sup>2</sup> is equivalent to 1 MPa.

**NOTE 4:** The material designation is in accordance with EN 1560.

**Table 2: Minimum impact resistance values measured on V-notched test pieces machined from separately cast samples**

Material designation		Minimum impact resistance values in Joules					
		at room temperature (23±5) °C		at (-20±2) °C		at (-40±2) °C	
Symbol	Number	mean value from 3 tests	individual value	mean value from 3 tests	individual value	mean value from 3 tests	individual value
EN-GJS-350-22-LT <sup>1)</sup>	EN-JS1015	-	-	-	-	12	9
EN-GJS-350-22-RT <sup>2)</sup>	EN-JS1014	17	14	-	-	-	-
EN-GJS-400-18-LT <sup>1)</sup>	EN-JS1025	-	-	12	9	-	-
EN-GJS-400-18-RT <sup>2)</sup>	EN-JS1024	14	11	-	-	-	-

<sup>1)</sup> LT for low temperature

<sup>2)</sup> RT for room temperature

NOTE 1: The values for these materials apply to castings cast in sand moulds of comparable thermal diffusivity. Subject to amendments to be agreed upon in the order, they can apply to castings obtained by alternative methods.

NOTE 2: Whatever the method used for obtaining the castings, the grades are based on the mechanical properties measured on test pieces taken from samples separately cast in a sand mould or a mould of comparable thermal diffusivity.

NOTE 3: The material designation is in accordance with EN 1560.

## 7.2 Test pieces machined from cast-on samples

### 7.2.1 General

The mechanical properties of spheroidal graphite cast iron test pieces shall be as specified in tables 3 and 4, and, if applicable, in accordance with the requirements given in 7.2.2.

### 7.2.2 Impact test

The particular impact resistance values given in table 4 for room and low temperature applications, if applicable, shall only be determined if specified by the purchaser by the time of acceptance of the order.

**Table 3: Mechanical properties measured on test pieces machined from cast-on samples**

Material designation		Relevant wall thickness $t$	Tensile strength $R_m$	0,2% proof stress $R_{p0.2}$	Elongation $A$
Symbol	Number	mm	N/mm <sup>2</sup> min.	N/mm <sup>2</sup> min.	% min.
EN-GJS-350-22U-LT <sup>1)</sup>	EN-JS1019	$t \leq 30$	350	220	22
		$30 < t \leq 60$	330	210	18
		$60 < t \leq 200$	320	200	15
EN-GJS-350-22U-RT <sup>2)</sup>	EN-JS1029	$t \leq 30$	350	220	22
		$30 < t \leq 60$	330	220	18
		$60 < t \leq 200$	320	210	15
EN-GJS-350-22U	EN-JS1032	$t \leq 30$	350	220	22
		$30 < t \leq 60$	330	220	18
		$60 < t \leq 200$	320	210	15
EN-GJS-400-18U-LT <sup>1)</sup>	EN-JS1049	$t \leq 30$	400	240	18
		$30 < t \leq 60$	390	230	15
		$60 < t \leq 200$	370	220	12
EN-GJS-400-18U-RT <sup>2)</sup>	EN-JS1059	$t \leq 30$	400	250	18
		$30 < t \leq 60$	390	250	15
		$60 < t \leq 200$	370	240	12
EN-GJS-400-18U	EN-JS1062	$t \leq 30$	400	250	18
		$30 < t \leq 60$	390	250	15
		$60 < t \leq 200$	370	240	12
EN-GJS-400-15U	EN-JS1072	$t \leq 30$	400	250	15
		$30 < t \leq 60$	390	250	14
		$60 < t \leq 200$	370	240	11
EN-GJS-450-10U	EN-JS1132	$t \leq 30$ $30 < t \leq 60$ $60 < t \leq 200$	450 to be agreed between the manufacturer and the purchaser	310	10
EN-GJS-500-7U	EN-JS1082	$t \leq 30$	500	320	7
		$30 < t \leq 60$	450	300	7
		$60 < t \leq 200$	420	290	5
EN-GJS-600-3U	EN-JS1092	$t \leq 30$	600	370	3
		$30 < t \leq 60$	600	360	2
		$60 < t \leq 200$	550	340	1
EN-GJS-700-2U	EN-JS1102	$t \leq 30$	700	420	2
		$30 < t \leq 60$	700	400	2
		$60 < t \leq 200$	660	380	1
EN-GJS-800-2U	EN-JS1112	$t \leq 30$	800	480	2
		$30 < t \leq 60$	to be agreed between the manufacturer and the purchaser		
		$60 < t \leq 200$			
EN-GJS-900-2U	EN-JS1122	$t \leq 30$	900	600	2
		$30 < t \leq 60$	to be agreed between the manufacturer and the purchaser		
		$60 < t \leq 200$			

<sup>1)</sup> LT for the low temperature

<sup>2)</sup> RT for room temperature

NOTE 1: The properties of a cast-on test piece cannot reflect exactly the properties of the casting itself, but can be a better approximation than those obtained on a separately cast sample. Further values are given in annex D for guidance.

NOTE 2: 1 N/mm<sup>2</sup> is equivalent to 1 MPa.

NOTE 3: The material designation is in accordance with EN 1560.

**Table 4: Minimum impact resistance values measured on V-notched test pieces machined from cast-on samples**

Material designation		Relevant wall thickness <i>t</i> mm	Minimum impact resistance values in Joules					
			at room temperature (23±5) °C		at (-20±2) °C		at (-40±2) °C	
Symbol	Number		mean value from 3 tests	individual value	mean value from 3 tests	individual value	mean value from 3 tests	individual value
EN-GJS-350-22U-LT <sup>1)</sup>	EN-JS1019	$t \leq 60$	-	-	-	-	12	9
		$60 < t \leq 200$	-	-	-	-	10	7
EN-GJS-350-22U-RT <sup>2)</sup>	EN-JS1029	$t \leq 60$	17	14	-	-	-	-
		$60 < t \leq 200$	15	12	-	-	-	-
EN-GJS-400-18U-LT <sup>1)</sup>	EN-JS1049	$30 < t \leq 60$	-	-	12	9	-	-
		$60 < t \leq 200$	-	-	10	7	-	-
EN-GJS-400-18U-RT <sup>2)</sup>	EN-JS1059	$30 < t \leq 60$	14	11	-	-	-	-
		$60 < t \leq 200$	12	9	-	-	-	-

<sup>1)</sup> LT for low temperature

<sup>2)</sup> RT for room temperature

NOTE 1: The values for the materials normally apply to castings with thicknesses between 30 mm and 200 mm and with a mass greater than 2 000 kg or when the relevant wall thickness may vary between 30 mm and 200 mm.

NOTE 2: The properties of a cast-on test piece cannot reflect exactly the properties of the casting itself, but can be a better approximation than those obtained on a separately cast sample. Further values are given in annex D for guidance.

NOTE 3: 1 N/mm<sup>2</sup> is equivalent to 1 MPa.

NOTE 4: The material designation is in accordance with EN 1560.

### 7.3 Test pieces machined from samples cut from a casting

If applicable, the manufacturer and the purchaser shall agree on:

- the place(s) on a casting where the sample(s) shall be taken;
- the mechanical properties that shall be measured;
- the values of these mechanical properties.

NOTE 1: The properties of castings are not uniform because of the complexity and variation in section thickness.

NOTE 2: Tables 1 to 4 may be used for guidance on the likely properties within the casting, but the properties can be equal to or lower than those given in tables 1 to 4. The values given in tables 1 and 2 are more relevant to smaller castings, and those in tables 3 and 4 are more relevant to larger castings. Further values are given for guidance in annex D.

## **7.4 Classification as a function of hardness**

The hardness shall only be specified when agreed between the manufacturer and the purchaser (see annex A).

## **7.5 Graphite structure**

The graphite structure shall be mainly of form V and VI in accordance with EN ISO 945 : 1994. A more precise definition can be agreed by the time of acceptance of the order.

This structure shall be confirmed either by metallographic examination or by non-destructive methods. In case of dispute, the result of the microscopic examination shall prevail.

## **8 Sampling**

### **8.1 General**

Samples shall be provided to represent the casting(s) produced.

Samples shall be made from the same metal used to produce the casting(s) which they represent (see annex E).

### **8.2 Separately cast samples**

#### **8.2.1 Frequency and number of tests**

Samples representative of the material shall be produced at a frequency in accordance with the in-process quality assurance procedures adopted by the manufacturer.

In the absence of an in-process quality assurance procedure or any other agreement between the manufacturer and the purchaser, a minimum of one tensile test sample shall be produced to confirm the material at a frequency to be agreed between the manufacturer and the purchaser by the time of acceptance of the order.

When impact tests are agreed by the time of acceptance of the order, samples shall be produced at a frequency to be agreed between the manufacturer and the purchaser.

#### **8.2.2 Samples and test pieces**

The samples shall be cast separately in sand moulds at the same time as the castings and under representative spheroidization and inoculation treatments.

The samples shall meet the requirements of either figures 1, 2 or 3.

The samples shall not be removed from the mould at a temperature higher than that of the castings.

If the graphite spheroidizing treatment is carried out in the mould (in-mold method), the samples may be

- either cast side-by-side with the castings, with a joint running system
- or cast separately using a similar treatment method in the sample mould as the method used to produce the casting.

The samples shall be subjected to the same heat treatment, if any, as the castings which they represent.

The tensile test piece shown in figure 4 and, if applicable, the impact test piece shown in figure 5 shall be machined from a sample shown in figures 1 and 2 (hatched part) or from the sample shown in figure 3. Unless otherwise agreed, the choice of the option is left to the discretion of the manufacturer.

## **8.3 Cast-on samples**

### **8.3.1 Frequency and number of tests**

Cast-on samples are representative of the castings to which they are attached and also of all other castings of a similar wall thickness from the same test unit, or produced at the same time interval in accordance with the in-process quality assurance procedure used by the manufacturer.

One tensile test shall be carried out to confirm the material unless there has been a special agreement between the manufacturer and the purchaser.

When impact tests are agreed by the time of acceptance of the order, samples shall be produced at a frequency to be agreed between the manufacturer and the purchaser.

### **8.3.2 Samples and test pieces**

The samples from which the test pieces for tensile and/or impact test are taken are cast-on to the castings or the running system. Cast-on samples should be chosen in preference to separately cast samples when the unit mass of the castings is equal to or greater than 2 000 kg or when the relevant wall thickness varies between 30 mm and 200 mm.

When the mass of the casting exceeds 2 000 kg and its thickness exceeds 200 mm, only cast-on test samples shall be used. In this case, the dimensions of the cast-on sample shall be agreed by the manufacturer and the purchaser by the time of acceptance of the order.

The positioning of the cast-on samples shall be agreed between the manufacturer and the purchaser by the time of acceptance of the order, taking into account the shape of the casting and the running system, in order to avoid any unfavourable effect on the properties of the adjacent material.

The samples shall have the shape and dimensions indicated in figure 6.

Unless otherwise agreed, when castings are to be heat treated, the cast-on samples shall not be separated from the castings until after the heat treatment.

The test pieces shall be in accordance with figure 4 and figure 5.

## **8.4 Samples cut from a casting**

### **8.4.1 General**

In addition to the requirements of the material, the manufacturer and the purchaser may agree on the properties required at stated positions in the casting. These properties shall be determined by testing machined test pieces cut from the casting at these stated positions. These test pieces should have a diameter equal to or smaller than  $\frac{1}{3}$  of the casting wall thickness and should be larger than  $\frac{1}{5}$  of the casting wall thickness. In the case of large individual castings trepanned samples may be taken at agreed positions in the casting which are to be stated.

### **8.4.2 Other conditions**

The position on the casting from where the sample is cut shall be in an area where the casting wall thickness is close to the relevant wall thickness of the casting.

For the purpose of determining the size of the test piece to be used, the purchaser shall, by the time of acceptance of the order, indicate to the manufacturer which are the important sections. In the absence of any direction by the purchaser, the manufacturer may choose the diameter of the test piece to be used.

## 9 Test methods

### 9.1 Tensile test

The tensile test shall be carried out in accordance with EN 10002-1. The preferred test piece diameter is 14 mm, but, for technical reasons and for test pieces machined from castings, it is permitted to use a test piece of different diameter (see figure 4). In either case the original gauge length of the test piece shall conform to the formula:

$$L_0 = 5,65 \times \sqrt{S_0} = 5 \times d$$

where:

$L_0$  is the original gauge length;

$S_0$  is the original cross-section area of the test piece;

$d$  is the diameter of the test piece along the gauge length.

If the above formula for  $L_0$  is not applicable, then an agreement shall be made between the manufacturer and the purchaser on the dimensions of the test piece.

### 9.2 Impact test

The impact test shall be carried out on three Charpy impact test pieces (see figure 5) in accordance with EN 10045-1 using test equipment with available energy compatible with the properties of the spheroidal graphite cast iron being tested.

### 9.3 Hardness test

When agreed between the manufacturer and the purchaser, the hardness shall be determined as Brinell hardness in accordance with EN 10003-1. Other hardness tests may also be agreed.

The test shall be carried out on the test pieces or at one or several points on the castings after preparation of the testing area in accordance with the agreement made by the manufacturer and the purchaser.

If the measuring points are not the subject of an agreement, they shall be chosen by the manufacturer.

Further information on hardness is given in annex A.

## 10 Retests

### 10.1 Need for retests

Retesting shall be carried out if a test is not valid.

A test is not valid if there is:

- a) a faulty mounting of the test piece or defective operation of the test machine;
- b) a defective test piece because of incorrect pouring or incorrect machining;
- c) a fracture of the tensile test piece outside the gauge length;
- d) a casting defect in the test piece, evident after fracture.

In all cases, a new test piece shall be taken from the same sample or a duplicate sample cast at the same time. The result of the retest shall be used.

## 10.2 Procedure for retests

If any test gives results which do not conform to the specified requirements, for reasons other than those given in 10.1, two retests shall be carried out for each failed test.

The casting(s) represented by the test shall be regarded as conforming to the specified requirements if both of the retests give satisfactory results as indicated in 7.1, 7.2 and 7.3.

However, the castings represented by the retests shall be regarded as non-conforming to this standard if the retests are valid but one of the results does not satisfy the specified property.

Unless otherwise specified, in the case of castings in the as-cast conditions which have non conforming properties, a heat treatment can be carried out.

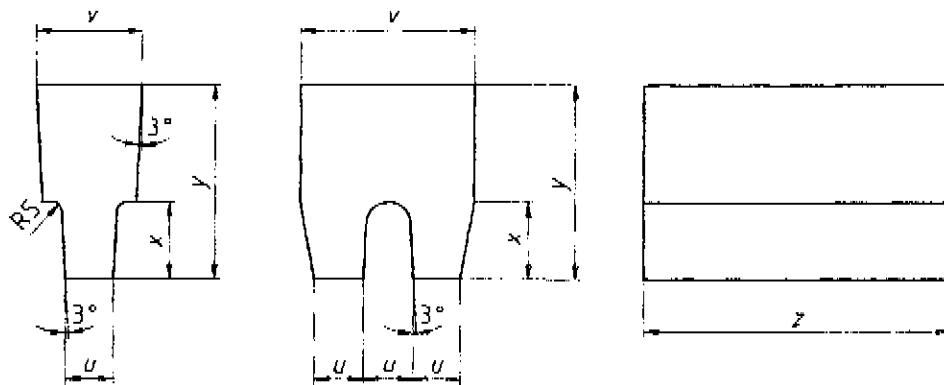
In the case of castings which have undergone a heat treatment and for which the test results are not valid, the manufacturer shall be permitted to re-heat-treat the castings and the representative samples. In this event, the samples shall receive the same number of heat treatments as the castings.

If the results of the tests carried out on the test pieces machined from the re-heat-treated samples are satisfactory, then the re-heat-treated castings shall be regarded as conforming to the specified requirements or to this standard.

The number of re-heat treatment cycles shall not exceed two.

Types I, IIa, III and IV

Type IIb



Dimensions in millimetres

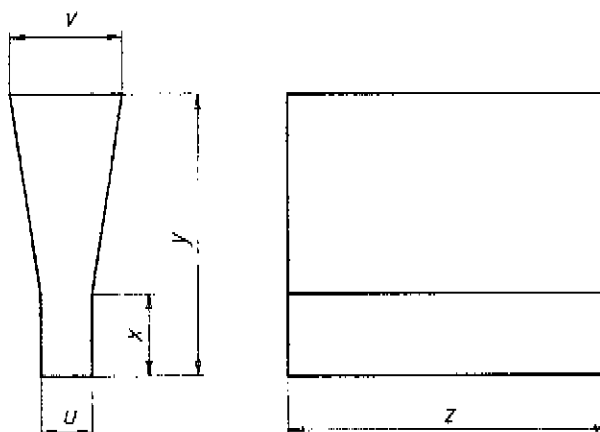
Dimension	Type				
	I	IIa	IIb	III	IV
$u$	12,5	25	25	50	75
$v$	40	55	90	90	125
$x$	30	40	40 or 50	60	65
$y^1)$	80	100	100	150	165
$z^2)$	A function of the test piece length				
<sup>1)</sup> For information only <sup>2)</sup> $z$ shall be chosen to allow a test piece of dimensions shown in figure 4 to be machined from the sample.					

The thickness of the sand mould surrounding the samples shall be

- 40 mm minimum for types I, IIa and IIb;
- 80 mm minimum for types III and IV.

NOTE: For the manufacture of thin-walled castings or castings in metal moulds, the tensile properties may, by agreement between the manufacturer and the purchaser, be determined on test pieces taken from samples of thickness  $u$  less than 12,5 mm.

Figure 1: Separately cast samples (option 1)



Dimensions in millimetres

Dimension	Type			
	I	II	III	IV
$u$	12,5	25	50	75
$v$	40	55	100	125
$x$	25	40	50	65
$y^1)$	135	140	150	175
$z^2)$	A function of the test piece length			
<sup>1)</sup> For information only <sup>2)</sup> $z$ shall be chosen to allow a test piece of dimensions shown in figure 4 to be machined from the sample.				

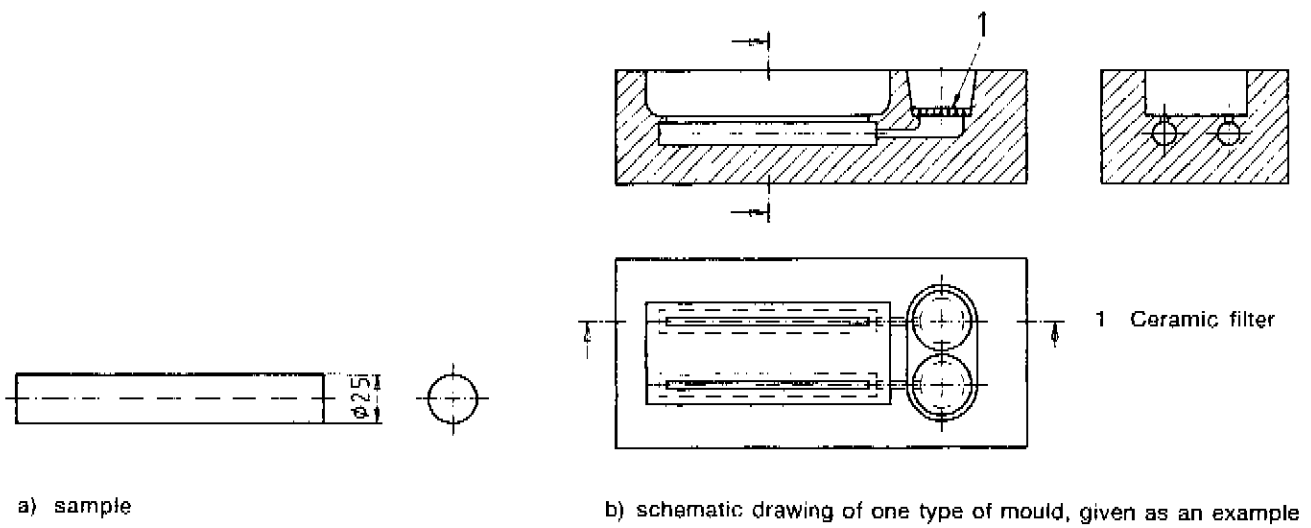
The thickness of the sand mould surrounding the samples shall be

- 40 mm minimum for types I and II;
- 80 mm minimum for types III and IV.

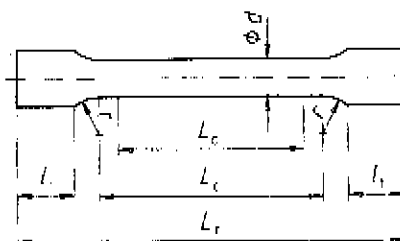
**NOTE:** For the manufacture of thin-walled castings or castings in metal moulds, the tensile properties may, by agreement between the manufacturer and the purchaser, be determined on test pieces taken from samples of thickness  $u$  less than 12,5 mm.

**Figure 2: Separately cast samples (option 2)**

Dimensions in millimetres



**Figure 3: Separately cast samples (option 3)**



Tensile test piece dimensions

Dimensions in millimetres

$d$	$L_0$	$L_c$ <sup>1)</sup> min.
5	25	30
7	35	42
10	50	60
14 <sup>2)</sup>	70	84
20	100	120
<sup>1)</sup> In principle <sup>2)</sup> Preferred dimension		

where:

$L_0$  is the original gauge length; i.e.  $L_0 = 5 \times d$ ;

$d$  is the diameter of the test piece along the gauge length;

$L_c$  is the parallel length;  $L_c > L_0$  (in principle  $L_c - L_0 > d$ );

$L_r$  is the total length of the test piece, which depends on  $L_c$  and  $l_r$ .

NOTE: The method of gripping the ends of the test piece, together with their length  $l_r$ , may be agreed between the manufacturer and the purchaser.

Figure 4: Tensile test piece

Dimensions in millimetres

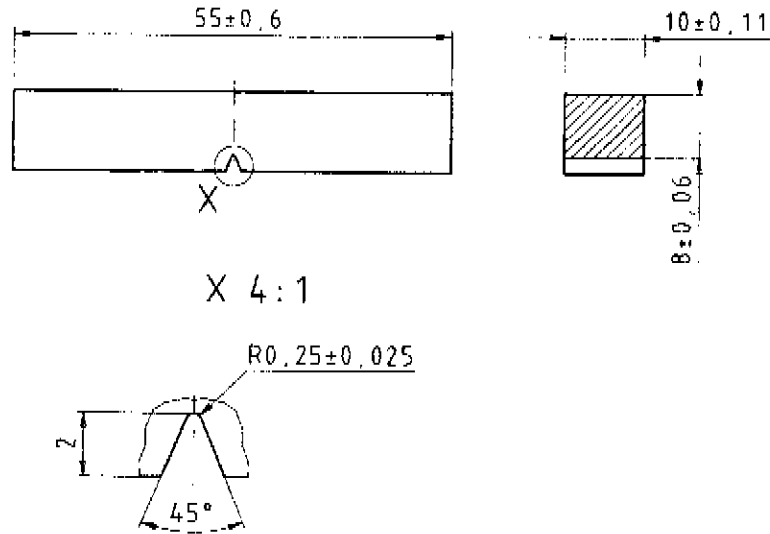
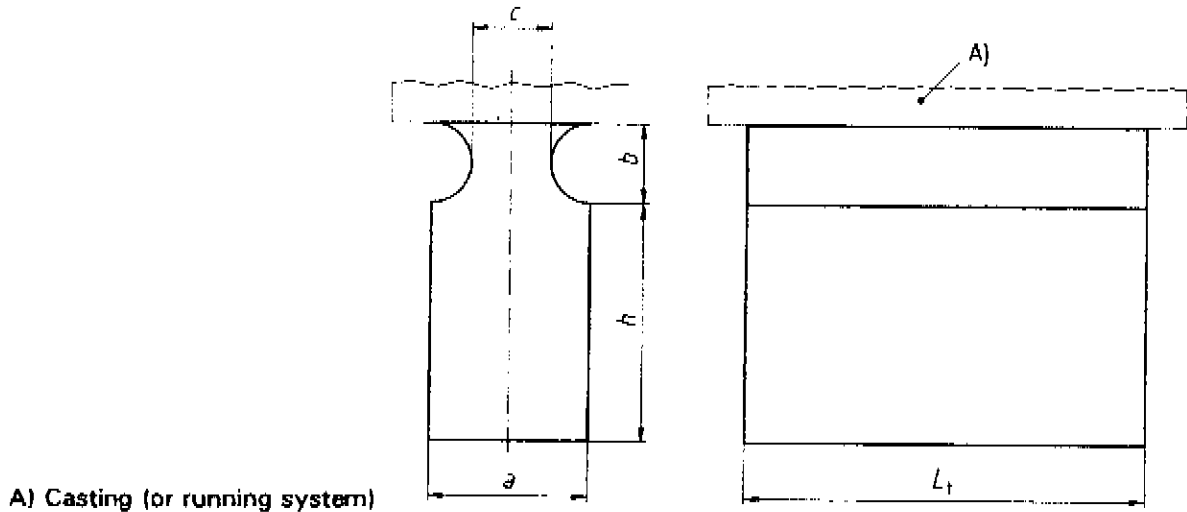


Figure 5: Charpy-notched impact test piece



A) Casting (or running system)

Dimensions in millimetres

Type	Relevant wall thickness of castings $t$	$a$	$b$ max.	$c$ min.	$h$	$L_1$
I	$30 < t \leq 60$	40	30	20	40 to 60	<sup>1)</sup>
II	$60 < t \leq 200$	70	52,5	35	70 to 105	<sup>1)</sup>

<sup>1)</sup>  $L_1$  shall be chosen to allow a test piece of a dimension shown in figure 4 to be machined from the sample.

NOTE: If smaller dimensions are agreed, the following relationships apply:

$$b = 0,75 \times a \text{ and } c = \frac{a}{2}$$

For further guidance, see figure 2.

Figure 6: Cast-on sample

## Annex A (normative)

### Classification as a function of hardness

This annex is only applicable when its requirements have been agreed by the manufacturer and the purchaser by the time of acceptance of the order.

#### A.1 Purpose

Within the provision of this European Standard, spheroidal graphite cast iron can be classified in terms of hardness values additionally or alternatively to the classification in terms of tensile strength.

When tensile properties are required in addition to hardness, they shall be agreed by the manufacturer and the purchaser by the time of acceptance of the order.

#### A.2 Classification

The hardness classes for the different materials shall be as specified in table A.1. Table A.1 also gives other properties for information only.

Table A.1

Material designation		Brinell hardness range HB	Other properties (for information only)	
Symbol	Number		$R_m$ N/mm <sup>2</sup>	$R_{p0.2}$ N/mm <sup>2</sup>
EN-GJS-HB130	EN-JS2010	less than 160	350	220
EN-GJS-HB150	EN-JS2020	130 to 175	400	250
EN-GJS-HB155	EN-JS2030	135 to 180	400	250
EN-GJS-HB185	EN-JS2040	160 to 210	450	310
EN-GJS-HB200	EN-JS2050	170 to 230	500	320
EN-GJS-HB230	EN-JS2060	190 to 270	600	370
EN-GJS-HB265	EN-JS2070	225 to 305	700	420
EN-GJS-HB300 <sup>1)</sup>	EN-JS2080 <sup>1)</sup>	245 to 335	800	480
EN-GJS-HB330 <sup>1)</sup>	EN-JS2090 <sup>1)</sup>	270 to 360	900	600

<sup>1)</sup> EN-GJS-HB300 (EN-JS2080) and EN-GJS-HB330 (EN-JS2090) are not recommended for thick section castings.

NOTE: 1 N/mm<sup>2</sup> is equivalent to 1 MPa.

When necessary and by agreement between the manufacturer and the purchaser, a narrower hardness range may be adopted at the agreed position on the casting; a range between 30 and 40 Brinell hardness units is commonly acceptable.

#### A.3 Sampling

Each hardness test shall be carried out on a casting or on a test piece at locations agreed by the manufacturer and the purchaser. If the locations have not been defined in an agreement the test shall be carried out at representative locations chosen by the manufacturer.

#### **A.4 Test method**

The hardness test shall be carried out in accordance with EN 10003-1.

If it is not possible to carry out the hardness test on the casting itself then, by agreement between the manufacturer and the purchaser, it may be carried out on a knob cast-on to the casting itself.

If the test is carried out on a cast-on knob, this shall not be removed until after any required heat treatment has been carried out.

If the test is carried out on a test piece taken from a separately cast sample, this shall first be subjected to any heat treatment required for the castings of which it is representative.

#### **A.5 Number and frequency of hardness tests**

The number and frequency of hardness tests can be the subject of an agreement between the manufacturer and the purchaser by the time of acceptance of the order.

#### **A.6 Microstructure**

In spheroidal graphite cast irons, the lowest hardness is achieved with a ferritic matrix. The hardness increases with the amount of eutectoid carbide (pearlite).

Eutectic carbide increases hardness but is normally undesirable and unlikely to be present in more than a very small amount.

Annex B (informative)

Technical data of spheroidal graphite cast irons

Table B.1 gives typical properties of spheroidal graphite cast iron. Figure B.1 gives examples of the relationships between Brinell hardness and tensile strength  $R_m$  of spheroidal graphite cast irons.

Table B.1: Typical properties<sup>1)</sup>

Characteristic	Unit	Material designation									
		EN-GJS-350-22 (EN-JS1010)	EN-GJS-400-18 (EN-JS1020)	EN-GJS-450-10 (EN-JS1040)	EN-GJS-500-7 (EN-JS1050)	EN-GJS-600-3 (EN-JS1060)	EN-GJS-700-2 (EN-JS1070)	EN-GJS-800-2 (EN-JS1080)	EN-GJS-900-2 (EN-JS1090)		
Shear strength	N/mm <sup>2</sup>	315	360	405	450	540	630	720	810		
Torsional strength	N/mm <sup>2</sup>	315	360	405	450	540	630	720	810		
Modulus of elasticity E, (tension and compression)	GN/m <sup>2</sup>	169	169	169	169	174	176	176	176		
Poisson's ratio $\nu$		0,275	0,275	0,275	0,275	0,275	0,275	0,275	0,275		
Fatigue limit (Wöhler) <sup>2)</sup> (rotating bending) unnotched <sup>3)</sup> ( $\varnothing$ 10,8 mm)	N/mm <sup>2</sup>	180	195	210	224	248	280	304	317		
Fatigue limit (Wöhler) <sup>2)</sup> (rotating bending) notched <sup>4)</sup> ( $\varnothing$ 10,6 mm)	N/mm <sup>2</sup>	114	122	128	134	149	168	182	190		
Compression strength	N/mm <sup>2</sup>	-	700	700	800	870	1 000	1 150	-		
Fracture toughness $K_{Ic}$	MPa · $\sqrt{m}$	31	30	23	25	20	15	14	14		
Thermal conductivity at 300 °C	W/(K · m)	36,2	36,2	36,2	35,2	32,5	31,1	31,1	31,1		
Specific heat capacity 20 °C to 500 °C	J/(kg · K)	515	515	515	515	515	515	515	515		
Linear expansion coefficient 20 °C to 400 °C	$\mu m/m \cdot K$	12,5	12,5	12,5	12,5	12,5	12,5	12,5	12,5		
Density	kg/dm <sup>3</sup>	7,1	7,1	7,1	7,1	7,2	7,2	7,2	7,2		
Maximum permeability	$\mu H/m$	2 136	2 136	2 136	1 596	866	501	501	501		
Hysteresis loss ( $B = 1 T$ )	J/m <sup>3</sup>	600	600	600	1 335	2 248	2 700	2 700	2 700		
Resistivity	$\mu\Omega \cdot m$	0,50	0,50	0,50	0,51	0,53	0,54	0,54	0,54		
Predominant structure		ferrite	ferrite	ferrite	ferrite-pearlite	pearlite-ferrite	pearlite	pearlite or tempered martensite	tempered martensite		

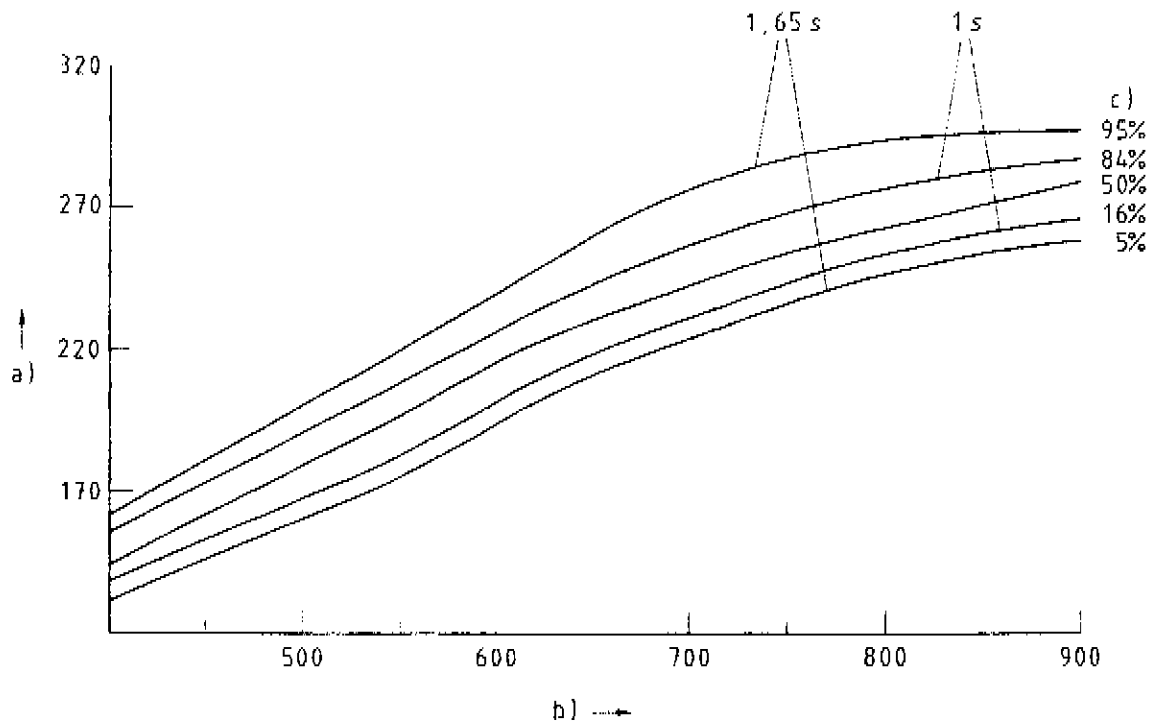
<sup>1)</sup> For details, see [1] in annex C.

<sup>2)</sup> Fatigue limit test pieces

<sup>3)</sup> Unnotched – In annealed ferritic spheroidal graphite cast iron the fatigue limit is about 0,5 x tensile strength in spheroidal graphite cast iron with a tensile strength of 370 N/mm<sup>2</sup>. The ratio decreases with increase in tensile strength until, in pearlitic and quenched and tempered spheroidal graphite cast iron, the fatigue limit is approximately 0,4 x tensile strength. The ratio decreases further when tensile strengths exceed 740 N/mm<sup>2</sup>.

<sup>4)</sup> Notched – For a test piece of 10,6 mm diameter at notch with a circumferential 45° V-notch having a radius of 0,25 mm, the fatigue limit of annealed spheroidal graphite cast iron decreases to a value of about 0,63 x fatigue limit of unnotched test pieces in spheroidal graphite cast iron with a tensile strength of 370 N/mm<sup>2</sup>. This figure decreases as the tensile strength of a ferritic spheroidal graphite cast iron increases. In spheroidal graphite cast iron with intermediate strengths and in pearlitic spheroidal graphite cast iron and quenched and tempered spheroidal graphite cast iron, the fatigue limit of notched test pieces is approximately 0,6 x the fatigue limit of unnotched test pieces.

<sup>5)</sup> For large castings, it can also be pearlite.  
NOTE 1: The notched test pieces are illustrated in [2] and [3], see annex C.  
NOTE 2: 1 N/mm<sup>2</sup> is equivalent to 1 MPa.



s = standard deviation

- a) Brinell hardness HB
- b) Tensile strength  $R_m$ , N/mm<sup>2</sup> (MPa)
- c) Confidence limit

**Figure B.1: Examples of the relationships between Brinell hardness and tensile strength  $R_m$  of spheroidal graphite cast iron, according to [4] in annex C.**

## **Annex C (informative)**

### **Bibliography**

In the preparation of this European Standard, use was made of a number of documents for reference purposes. These informative references are cited at the appropriate places in the text and the publications are listed hereafter.

EN 546

Ductile iron pipes, fittings, accessories and their joints for water pipelines – Requirements and test methods

EN 598

Ductile iron pipes, fittings, accessories and their joints for sewerage application – Requirements and test methods

EN 969

Ductile iron pipes, fittings, accessories and their joints for gas pipelines – Requirements and test methods

EN 1559-1

Founding – Technical conditions of delivery – Part 1: General

EN 1559-3

Founding – Technical conditions of delivery – Part 3: Additional requirements for iron castings

EN 1560

Founding – Designation system for cast iron – Material symbols and material numbers

ISO 2531 : 1991

Ductile iron pipes, fittings and accessories for pressure pipelines

[1] "Engineering data on nodular cast iron. SI-Units". BCIRA 1986

[2] Gilbert, G.N.J.: Journal of Research and Development 4 (1953) No. 10, p. 458–478 (BCIRA Research Report 348)

[3] Palmer, K.B.; Gilbert, G.N.J.: Journal of Research and Development 5 (1953) No. 1, p. 2–14 (BCIRA Research Report 361)

[4] Siefert, W.; Orth, K.: Giessereiforschung 23 (1971) Nr. 2, S. 43–55

## Annex D (informative)

Guidance values for 0,2% proof stress for test pieces machined from samples cut from the castings

Table D.1

Material designation		0,2% proof stress $R_{p0.2}$ N/mm <sup>2</sup> min. for wall thicknesses				
		Symbol	Number	up to and including 50 mm	over 50 mm up to and including 80 mm	over 80 mm up to and including 120 mm
EN-GJS-400-15C	EN-JS1073		250	240	230	230
EN-GJS-500-7C	EN-JS1083		290	280	270	260
EN-GJS-600-3C	EN-JS1093		360	340	330	320
EN-GJS-700-2C	EN-JS1103		400	380	370	360

## Annex E (normative)

### Formation of test units and number of tests

#### E.1 Examples of test units

Examples of test units are as follows:

- castings poured from the same ladle up to 2 000 kg of fettled castings; this may vary, where practical, by agreement between the manufacturer and the purchaser;
- a single casting, if its mass equals or exceeds 200 kg;
- for continuous pouring of large tonnages of spheroidal graphite cast iron, the maximum size of the test unit shall be restricted to the castings produced in two hours of pouring;
- if the graphite spheroidizing treatment is carried out on less than 2 000 kg, the test unit shall be taken as the castings produced from that quantity of treated metal.

NOTE: After heat treatment, a test unit will remain the same unless different heat treatments have been applied to distinct parts of the test unit. In such cases, these distinct parts will become separate test units.

#### E.2 Number of tests per test unit

Sampling and testing shall be carried out in accordance with clauses 8, 9 and 10. Sampling and testing shall be carried out on each test unit unless the in-process quality assurance system makes provision for amalgamation of test units. When the graphite spheroidizing treatment has been carried out in the mould, the formation of test units and the number of tests shall be agreed between the manufacturer and the purchaser by the time of acceptance of the order.