BS EN 1559-3:2011

BSI Standards Publication

# Founding — Technical conditions of delivery

## Part 3: Additional requirements for iron castings

bsi.

...making excellence a habit.™

**National foreword**

This British Standard is the UK implementation of EN 1559-3:2011. It supersedes BS EN 1559-3:1997 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ISE/111, Steel Castings and Forgings.

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 70174 0

ICS 77.140.80

**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 31 October 2011.

**Amendments issued since publication**

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

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

**EN 1559-3**

October 2011

ICS 77.140.80

Supersedes EN 1559-3:1997

English Version

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

Fonderie - Conditions techniques de fourniture - Partie 3: Spécifications complémentaires pour les pièces moulées en fonte

Gießereiwesen - Technische Lieferbedingungen - Teil 3: Zusätzliche Anforderungen an Eisengussstücke

This European Standard was approved by CEN on 17 September 2011.

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

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

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

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

**Management Centre: Avenue Marnix 17, B-1000 Brussels**

# Contents

Page

# Foreword

This document (EN 1559-3:2011) 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 April 2012, and conflicting national standards shall be withdrawn at the latest by April 2012.

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

This document supersedes EN 1559-3:1997.

Within its programme of work, Technical Committee CEN/TC 190 requested CEN/TC 190/WG 1 "Technical conditions of delivery and cast iron designation" to revise the following standard:

EN 1559-3, *Founding — Technical conditions of delivery — Part 3: Additional requirements for iron castings*

Annex C provides details of significant technical changes between this European Standard and the previous edition.

This standard is one of a series of European Standards for technical delivery conditions for castings. The other standards in this series are:

EN 1559-1, *Founding — Technical conditions of delivery — Part 1: General*

EN 1559-2, *Founding — Technical conditions of delivery — Part 2: Additional requirements for steel castings*

EN 1559-4, *Founding — Technical conditions of delivery — Part 4: Additional requirements for aluminium alloy castings*

EN 1559-5, *Founding — Technical conditions of delivery — Part 5: Additional requirements for magnesium alloy castings*

EN 1559-6, *Founding — Technical conditions of delivery — Part 6: Additional requirements for zinc alloy castings*

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

# Introduction

CEN/TC 190 "Foundry Technology" has prepared a series of material standards covering the following cast irons:

— grey cast irons [1];

— malleable cast irons [2];

— spheroidal graphite cast irons [3];

— ausferritic spheroidal graphite cast irons [4];

— abrasion resistant cast irons [5];

— austenitic cast irons [7];

— compacted (vermicular) graphite cast irons [8];

— low alloyed ferritic spheroidal graphite cast irons for elevated temperature applications [9].

In order to assist manufacturers and purchasers to prepare proper contractual arrangements and prevent misunderstanding, CEN/TC 190 approved the preparation of a series of standards covering technical delivery conditions. These have been prepared as separate parts.

This European Standard covers the additional technical delivery conditions for all the cast iron materials, e.g. optional information, manufacturing process, welding operation, additional requirements regarding the condition of the casting, test methods.

This European Standard cannot be used alone for compiling a specification for ordering and supplying iron castings, but as a complement to EN 1559-1.

The symbol ● against the clause reference indicates that the requirements of that clause of EN 1559-1 have to be met.

## 1 Scope

This European Standard specifies the additional technical delivery conditions for castings made from all cast iron materials.

This European Standard applies to iron castings produced in sand or permanent moulds or by centrifugal casting, continuous casting or investment casting.

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 287-6, *Qualification test of welders — Fusion Welding — Part 6: Cast iron*

EN 444, *Non-destructive testing — General principles for radiographic examination of metallic materials by X- and gamma-rays*

EN 571-1, *Non destructive testing — Penetrant testing — Part 1: General principles*

EN 583-1, *Non-destructive testing — Ultrasonic examination — Part 1: General principles*

EN 1011-8, *Welding — Recommendations for welding of metallic materials — Part 8: Welding of cast irons*

prEN 1369, *Founding — Magnetic particle testing*

EN 1370, *Founding — Examination of surface condition*

EN 1371-1, *Founding — Liquid penetrant testing — Part 1: Sand, gravity die and low pressure die castings*

EN 1559-1, *Founding — Technical conditions of delivery — Part 1: General*

EN 1560, *Founding — Designation system for cast iron — Material symbols and material numbers*

EN 12680-3, *Founding — Ultrasonic testing — Part 3: Spheroidal graphite cast iron castings*

EN 12681, *Founding — Radiographic examination*

EN 14784-1, *Non-destructive testing — Industrial computed radiography with storage phosphor imaging plates — Part 1: Classification of systems*

EN 14784-2, *Non-destructive testing — Industrial computed radiography with storage phosphor imaging plates — Part 2: General principles for testing of metallic materials using X-rays and gamma rays*

EN ISO 9934-1, *Non-destructive testing — Magnetic particle testing — Part 1: General principles (ISO 9934-1:2001)*

EN ISO 15614-3, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 3: Fusion welding of non-alloyed and low-alloyed cast irons (ISO 15614-3:2008)*

## 3 ● Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1559-1 and of the applicable material standard apply.

# 4 Information to be supplied by the purchaser

## 4.1 ● Mandatory information

The relevant wall thickness shall be given in the order.

## 4.2 Optional information

Where applicable, the enquiry and order shall include other details, such as requirements for

a) an as-cast condition;

NOTE Heat treatment of malleable cast irons or ausferritic spheroidal graphite cast irons is a function of the material and is at the discretion of the manufacturer to achieve the desired mechanical properties.

b) special or subsequent heat treatment if required (together with the heat-treatment conditions);

c) heat treatment for stress relieving; it shall be agreed upon between the manufacturer and the purchaser;

d) intentions to enamel, galvanize, plate, etc. the castings;

e) sequence of machining and final heat treatment in the fabrication process (for ausferritic spheroidal graphite iron castings);

f) formation of test units (unless already defined by material specifications it shall be in accordance with 8.3.1).

## 4.3 ● Drawings, patterns and tools

## 4.4 ● Information on the mass

## 4.5 ● Preliminary sample

## 4.6 ● Initial sample

# 5 Designations

The designation(s) of cast iron material(s) shall be in accordance with EN 1560.

NOTE Designations of cast iron materials are given in the applicable material standards.

# 6 Manufacture

## 6.1 ● Manufacturing process

## 6.2 Welding operations

### 6.2.1 ● General

Welding shall be performed by a qualified welder, in accordance with EN 287-6. Welding procedures shall be in accordance with EN ISO 15614-3 and based on the recommendations given in EN 1011-8.

### 6.2.2 ● Production welding

Production welding shall only be permitted according to a written agreement between the manufacturer and the purchaser.

Subject to an agreement between the manufacturer and the purchaser, the manufacturer may either undertake finishing welding generally and/or up to a certain limit without reference back to the purchaser or may be required to seek the purchaser's permission in specific cases.

NOTE EN 1562 includes a weldable grade: EN-GJMW-360-12 (5.4201).

# 7 Requirements

## 7.1 ● General

## 7.2 Material

### 7.2.1 ● Chemical composition

### 7.2.2 ● Mechanical properties

### 7.2.3 ● Other properties

## 7.3 Casting

### 7.3.1 ● Chemical composition

NOTE If post inoculation in the metal stream or in the moulds is carried out, there might be a slight deviation in analysis (silicon namely) between the composition of the liquid metal in the pouring device and the composition of the casting.

### 7.3.2 ● Mechanical properties

### 7.3.3 ● Outer and inner conditions (non destructive testing)

**7.3.3.1** The testing shall be performed according to the relevant European Standards as listed in Table 1. Other methods may be agreed between purchaser and manufacturer.

**Table 1 — Non Destructive test methods**

| Test method | Symbol | General principles, references | Test conditions, references |
|---|---|---|---|
| Liquid penetrant | PT | EN 571-1 | EN 1371-1 |
| Magnetic particle | MT | EN ISO 9934-1 | prEN 1369 |
| Ultrasonic | UT | EN 583-1 | EN 12680-3[a] |
| Radiographic | RT | EN 444<br>EN 14784-1<br>EN 14784-2 | EN 12681 |

[a] applicable to spheroidal graphite cast irons

NOTE Because some non-destructive testing methods are more suitable than others for iron castings, they should be discussed under the technical and economical aspects before agreement between the manufacturer and the purchaser.

**7.3.3.2** ●

**7.3.3.3** The selection of a non destructive testing method is dependent on the thickness and material of the casting and the position, orientation and size of possible discontinuities in the relevant section.

Different acceptance criteria can be specified for different areas of the same casting (e.g. marked zone and unmarked area). Moreover, for the same area of the casting different acceptance criteria can be specified according to the non destructive methods selected.

For all non destructive testing methods, the acceptance criteria (discontinuity levels) can be graded with increasing number and/or extent of indications.

Unless specifically agreed, discontinuities revealed on cast surfaces which are to be machined, are not to be regarded as discontinuities, when these discontinuities are totally removed by machining.

Guidelines for the specification of acceptance criteria for discontinuities are given in the informative Annex A.

**7.3.3.4** If applicable, the roughness of the cast or grinded surface shall be specified.

EN 1370 shall be used to specify the acceptance levels and shall be subject of an agreement between the manufacturer and the purchaser by the time of acceptance of the order.

Guidelines for the specification of acceptance criteria for the surface condition are given in the informative Annex B.

**7.3.4 ● Condition of the casting**

**7.3.5 ● Mass of the casting**

The mass can be calculated using the mass density given in the corresponding material standard.

**7.3.6 ● Additional requirements regarding the condition of the casting**

The microstructures to be examined, the tests to be applied and any other requirement to be determined shall be subject of an agreement between the manufacturer and the purchaser by the time of acceptance of the order.

# 8 Inspection

## 8.1 ● General

## 8.2 ● Type of inspection documents and type of inspection

The requirements given in the relevant material standard shall also apply.

## 8.3 Test unit

**8.3.1 ● Formation of test units**

**8.3.2 ● Size of test units**

The requirements given in the relevant material standard shall also apply.

**8.3.3 ● Inspection frequency**

The requirements given in the relevant material standard shall also apply.

### 8.4 ● Samples

The requirements given in the relevant material standard shall also apply.

### 8.5 ● Test

The requirements given in the relevant material standard shall also apply.

### 8.6 ● Invalidation of tests

### 8.7 ● Retests

### 8.8 ● Sorting and reprocessing

## 9 ● Marking

## 10 ● Packaging and surface protection

## 11 ● Complaints

# Annex A
(informative)

# Guidelines for the specification of acceptance criteria for the outer and inner conditions (non-destructive testing)

## A.1 General

These guidelines for the specification of acceptance criteria for casting discontinuities in iron castings can be applied to castings made of all types of cast iron in as-cast or machined condition. This Annex does not apply to the visual check of iron castings. (see Annex B).

## A.2 Casting discontinuities

The most common discontinuities are, a. o.:

— sand inclusions;

— slag inclusions;

— dross;

— gas porosities;

— shrinkage porosities.

## A.3 General requirements

— Maximum discontinuity indication size should be measured according to the rules given in the appropriate standard.

— Two or more discontinuities are to be combined according the rules given in the appropriate standard.

— The reference testing area should be 105 mm × 148 mm. If the casting surface or marked zone is smaller in area than this reference surface area, the number or total area of discontinuities should be proportionally reduced.

NOTE The area of 105 mm × 148 mm corresponds with the frames used in prEN 1369, EN 1370 and EN 1371-1.

## A.4 Discontinuity classes

Casting discontinuities can be classified into three discontinuity classes as shown in Table A.1.

These classes are based on the shape of the discontinuities, linear or non linear (defined in prEN 1369 and EN 1371-1), and position, surface or internal, of the discontinuities.

**Table A.1 — Discontinuity classes**

| | | |
|---|---|---|
| Discontinuity class 1 | Non linear discontinuities in surface | See Table A.2 |
| Discontinuity class 2 | Linear discontinuities in surface | See Table A.2 |
| Discontinuity class 3 | Internal discontinuities | See Table A.3 |

## A.5 Discontinuity levels

Five discontinuity levels "a" to "e" are specified for discontinuity classes 1, 2 and 3, and the discontinuity levels for the various discontinuity classes have been selected in such a way, that a certain discontinuity level corresponds to the same requirement or stress level. This information is based on a comparison of existing specifications on spheroidal graphite cast iron castings.

**Table A.2 — Discontinuities in the surface**

| **Discontinuity level** | **Discontinuity class 1 — Non-linear discontinuities** | | **Discontinuity class 2 — Linear discontinuities** | |
|---|---|---|---|---|
| | **Corresponding severity level according to prEN 1369** | **Corresponding severity level according to EN 1371-1** | **Corresponding severity level according to prEN 1369** | **Corresponding severity level according to EN 1371-1** |
| a[a] | SM001 | — | LM001 | LP001 |
| b | SM2 | SP1 | LM01 | LP01 |
| c | SM3 | SP2 | LM1 | LP1 |
| d | SM4 | SP4 | LM3 | LP3 |
| e | SM5 | SP5 | LM5 | LP5 |

NOTE prEN 1369 and EN 1371-1 characterize the severity level by the number of discontinuities, maximum length and maximum total area of discontinuities.

[a] Applicable to spheroidal graphite cast irons

**Table A.3 — Discontinuity class 3 — Internal discontinuities to be detected by ultrasonic testing according to EN 12680-3 or radiographic testing according to EN 12681**

| Discontinuity level | Corresponding severity level according to EN 12680-3 | Corresponding severity level[a] for spheroidal graphite cast iron castings with thickness ≤ 51 mm according to ASTM E 689 and ASTM E 446 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | A | B | CA | CB | CC | CD | D | E | F | G |
| | | Gas porosity | Sand and slag inclusion | Shrinkage | | | | Crack | Hot tear | Insert | Mottling |
| a | VU1.1 | A1 | B1 | CA1 | CB1 | CC1 | CD1 | Not permitted | | | |
| b | VU2.1 | A3 | B1 | CA1 | CB1 | CC1 | CD1 | | | | |
| c | VU3.1 | A4 | B3 | CA2 | CB2 | CC2 | CD2 | | | | |
| d | VU4.1 | A5 | B4 | CA3 | CB3 | CC3 | CD2 | | | | |
| e | VU5.1 | A5 | B5 | CA5 | CB4 | CC4 | CD3 | | | | |

[a] see EN 12681.

## A.6 Machined surfaces and bores

Discontinuity levels on machined surfaces and bores should be specified as discontinuities in the surface.

On some machined surfaces, a higher requirement can be specified for reason of e.g. bearing ratio, leak tightness, abrasion resistance or sliding properties and not primarily for strength.

To be able to comply with these requirements, it is important that the casting manufacturer should be informed about the machining process to be performed.

## A.7 Marked zones

If specific zones of a part are important in terms of strength or surface condition, these zones should be marked on the drawing with specified discontinuity class and discontinuity level.

The material may be grinded down to the minimum size indicated in the drawing to eliminate discontinuities, as long as no notches are formed.

# Annex B
(informative)

# Guidelines for the specification of acceptance criteria for surface condition (visual check)

## B.1 General

These guidelines for the specification of acceptance criteria for surface condition of iron castings can be applied to castings made of all types of cast irons.

All castings should be visually checked.

## B.2 Surface roughness

The casting area(s) where roughness is to be controlled should be clearly indicated on the drawing or in the specification. The category (shot blasted or grinded) and level should be stated. More than one category and level may be specified for a casting.

Information about the specification of the acceptance level(s) in relation to the requirement(s) and moulding process is given in Table B.1.

**Table B.1 — Acceptance levels for surface roughness**

| **Acceptance levels[a]** | | | | | | |
|---|---|---|---|---|---|---|
| Process | Shell moulding | | Greensand and cold setting sand moulding, small to medium sized castings | | Cold setting sand moulding, large castings | |
| Category | Shot blasted | Grinded | Shot blasted | Grinded | Shot blasted | Grinded |
| Exposed surface, highest requirement | 2/0S1 | 1/0S2 | 1S1[b] or A1[c] | 1S2 | 2S1 or A2 | 2S2 |
| Exposed surface | 1/0S1 | 1/0S2 | 2S1 or A2 | 2S2 | 3S1or A3 | 3S2 |
| Normal requirement | 1S1 or A1 | 1S2 | 3S1 or A3 | 3S2 | 6S1[d] or A4 | 5S2 or H1 |

[a] Acceptance level designation according EN 1370.

[b] BNIF comparators.

[c] SCRATA comparators.

[d] BNIF 5S1 is not permitted.

## B.3 Visual examination of surface irregularities

Examples for surface irregularities are:

— sand inclusions;

— slag inclusions;

— local excess or lack of material.

Surface irregularities can be facing outwards or inwards.

The casting area(s) where irregularities are to be controlled should be clearly indicated on the drawing or in the specification. The level, classification by dimension (VD) or comparator (VC) according to EN 1370 should be stated. More than one level may be specified for a casting.

Information about the specification of the acceptance level(s) in relation to the requirement(s) and moulding process is given in Table B.2.

**Table B.2 — Acceptance levels for surface irregularities**

| **Acceptance levels** | | | | |
|---|---|---|---|---|
| Recommended Process | Greensand and cold setting sand moulding, small to medium sized castings | | Cold setting sand moulding, large castings | |
| Category | Classification by | | | |
| Visual aspects | dimension | comparator | dimension | Comparator |
| Exposed surface, highest requirement | VD1 | — | VD2 | VC1 |
| Exposed surface | VD2 | VC1 | VD4 | VC2 |
| Normal requirement | VD4 | VC2 | VD6 | VC3 |
| Low requirement, hidden surface | VD6 | VC3 | VD8 | VC4 |

# Annex C
(informative)

# Significant technical changes between this European standard and the previous edition

**Table C.1 — Significant technical changes between this European standard and the previous edition**

| Clause/Paragraph/Table/Figure | Change |
|---|---|
| 7.3.3 | Information regarding the inner and outer condition of the casting and related non-destructive testing added; |
| Annex A | Informative Annex A with guidelines for the specification of acceptance criteria for the outer and inner conditions (non-destructive testing) added; |
| Annex B | Informative Annex B with guidelines for the specification of acceptance criteria for surface condition (visual check) added. |
| NOTE The technical changes referred include the significant technical changes from the EN revised but is not an exhaustive list of all modifications from the previous version. | |

# Bibliography

[1] EN 1561, *Founding — Grey cast irons*

[2] EN 1562, *Founding — Malleable cast irons*

[3] EN 1563, *Founding — Spheroidal graphite cast irons*

[4] EN 1564, *Founding — Ausferritic spheroidal graphite cast irons*

[5] EN 12513, *Founding — Abrasion resistant cast irons*

[6] EN 13018, *Non-destructive testing — Visual testing — General principles*

[7] EN 13835, *Founding — Austenitic cast irons*

[8] EN 16079, *Founding — Compacted (vermicular) graphite cast irons*

[9] EN 16124, *Founding — Low alloyed ferritic spheroidal graphite cast irons for elevated temperature application*

[10] ASTM E 446, *Standard Reference Radiographs for Steel Castings Up to 2 in. [51 mm] in Thickness*

[11] ASTM E 689, *Standard Reference Radiographs for Ductile Iron Castings*

*This page deliberately left blank*

# British Standards Institution (BSI)

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

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

## About us

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

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

## Information on standards

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

## Buying standards

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

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

## Subscriptions

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

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

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

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

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

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

**BSI Group Headquarters**

389 Chiswick High Road London W4 4AL UK

## Revisions

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

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

## Copyright



## Useful Contacts:

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

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

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

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

bsi.

...making excellence a habit.™