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**Livarstvo - Železove litine s kompaktnim (vermikularnim) grafitom**

Founding - Compacted (vermicular) graphite cast irons

Gießereiwesen - Gusseisen mit Vermiculargraphit

Fonderie - Fontes à graphite vermiculaire (compacté)

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## Founding - Compacted (vermicular) graphite cast irons

Fonderie - Fontes à graphite vermiculaire (compacté)

Gießereiwesen - Gusseisen mit Vermiculargraphit

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

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<b>Contents</b>	<b>Page</b>
European foreword .....	4
Introduction .....	5
1 Scope.....	7
2 Normative references.....	7
3 Terms and definitions.....	7
4 Designation .....	8
5 Order information .....	8
6 Manufacture.....	9
7 Requirements.....	9
7.1 General.....	9
7.2 Test pieces machined from separately cast samples.....	9
7.3 Test pieces machined from side-by-side and cast-on samples.....	9
7.4 Test pieces machined from samples cut from a casting.....	10
7.5 Hardness .....	11
7.6 Graphite structure .....	11
8 Sampling.....	11
8.1 General.....	11
8.2 Cast samples .....	12
8.2.1 Size of cast sample.....	12
8.2.2 Frequency and number of tests.....	12
8.2.3 Separately cast samples.....	12
8.2.4 Side-by-side cast samples .....	12
8.2.5 Cast-on samples.....	13
8.2.6 Test pieces machined from cast samples .....	13
8.3 Samples cut from a casting .....	13
9 Test methods .....	17
9.1 Tensile test.....	17
9.2 Hardness test.....	19
9.3 Graphite structure examination.....	20
10 Retests.....	20
10.1 Need for retests .....	20
10.2 Test validity .....	20
10.3 Nonconforming test results.....	20
10.4 Heat treatment of samples and castings.....	20
11 Inspection documentation.....	21
Annex A (informative) Additional information on properties and typical applications of compacted (vermicular) graphite cast irons .....	22
Annex B (informative) Compacted (vermicular) graphite cast iron nodularity evaluation.....	26
B.1 Nodularity definition.....	26
B.2 Factors influencing nodularity.....	26

<b>B.3</b>	<b>Basic method for nodularity evaluation.....</b>	<b>26</b>
<b>B.4</b>	<b>Microscope settings for sound nodularity evaluation (see also ISO/TR 945-2).....</b>	<b>26</b>
<b>B.5</b>	<b>Roundness of graphite nodules.....</b>	<b>26</b>
<b>B.6</b>	<b>Classification of rounded graphite particles by a shape factor.....</b>	<b>27</b>
<b>B.7</b>	<b>Intermediate graphite particles, understanding sterical effects.....</b>	<b>27</b>
<b>B.8</b>	<b>Calculation of percentage nodularity.....</b>	<b>28</b>
<b>B.9</b>	<b>Location of testing.....</b>	<b>28</b>
<b>B.10</b>	<b>Rating chart for determining nodularity in compacted (vermicular) graphite cast irons.....</b>	<b>28</b>
<b>B.11</b>	<b>Rating chart for the roundness of graphite particles, assigning shape factors.....</b>	<b>29</b>
<b>Annex C (informative)</b>	<b>Guidance values for tensile properties measured on test pieces machined from samples cut from a casting.....</b>	<b>31</b>
<b>Annex D (normative)</b>	<b>Sectioning procedure for cast samples.....</b>	<b>32</b>
<b>Annex E (informative)</b>	<b>Comparison of compacted (vermicular) graphite cast iron material designations according to EN 1560 and ISO/TR 15931 [4][5].....</b>	<b>33</b>
<b>Annex F (informative)</b>	<b>Changes since the last version.....</b>	<b>34</b>
<b>Bibliography.....</b>		<b>35</b>

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**prEN 16079:2020 (E)**

## **European foreword**

This document (prEN 16079:2020) has been prepared by Technical Committee CEN/TC 190 “Foundry technology”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 16079:2011.

Within its programme of work, Technical Committee CEN/TC 190 requested CEN/TC 190/WG 5 “Grey cast iron and compacted graphite cast iron” to prepare EN 16079.

Annex F provides details of significant technical changes between this document and the previous edition.

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## Introduction

This document classifies compacted (vermicular) graphite cast irons (CGI), in accordance with the mechanical properties of the material.

The properties of compacted (vermicular) graphite cast irons depend on their graphite and matrix microstructure. A moderate section sensitivity results from different cooling velocities in different wall thickness of the casting. When designating a material grade it needs consideration.

Table 1 defines material grades according to their mechanical properties.

- 1) Table 1 designates (verifies) the cast material in the foundry (process quality assurance). The customer designates the material grade in view of requirements from component design. The choice of cast samples is based on the relevant wall thickness to ensure comparability.
- 2) Table 1 defines minimum property values (ultimate tensile strength) for each material grade, based on cast samples. For the casting itself, typical property values are given in Table C.1.

Cast iron materials are molten from steel scraps of different compositions (circular economy), pig iron, alloying elements, carburizers, etc., neither using ready alloys nor applying secondary metallurgical methods. Depending on the production route used, the chemical composition can vary (Clause 6). The mechanical properties prevail.

**Material designation.** The customer designates the material grade based on design requirements (load). In a casting with complex shape and different wall thickness, property values can vary over the casting, due to section sensitivity. An 'over all' designation of the entire casting by only one cast sample is not representative.

If only one cast sample is possible (e.g. due to cost reasons, space in the mould, or when cutting a sample from the casting is not possible), then it represents the most interesting, relevant wall thickness.

In case of an inappropriate material designation, the desired properties may not be reached locally, in the most interesting, relevant section of the cast component.

This can be avoided by co-operation of customer and foundry early in the design stage. The foundry can control the solidification of the casting and thus fulfil locally required properties.

NOTE The designation system by number is based on the structure and rules of EN 10027-2 [8] and so corresponds with the European numbering system for steel and other materials.

**Property values.** The cast sample represents the properties in the relevant wall thickness section of the casting, given by component design. The minimum tensile properties to be obtained in cast samples represent recent process ability for all types of compacted graphite cast iron production.

Anticipated values in the casting (Table C.1) are slightly decreasing with increasing wall thickness.

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

- separately cast samples,
- side by side cast samples,
- cast-on samples, or
- samples cut from a casting.

For many applications, tensile strength and hardness are not the only properties of interest to casting designers. Other mechanical or physical properties can be decisive for the use of grey iron.

**prEN 16079:2020 (E)**

Annex A gives additional information on properties and typical applications of compacted (vermicular) graphite cast irons.

Annex B describes a procedure for the determination of nodularity of the microstructure. It includes reference images for visual analysis and guidelines for automated image analysis.

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## 1 Scope

This document defines the grades and the corresponding requirements for compacted (vermicular) graphite cast irons.

This document specifies 4 grades of compacted (vermicular) graphite cast iron by a classification based on the minimum mechanical properties measured on machined test pieces prepared from cast samples or samples cut from a casting.

This document does not cover technical delivery conditions for iron castings (see EN 1559-1 [1] and EN 1559-3 [2]).

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 10204, *Metallic products — Types of inspection documents*

EN ISO 945-1, *Microstructure of cast irons — Part 1: Graphite classification by visual analysis (ISO 945-1)*

EN ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method (ISO 6506-1)*

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

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## 3 Terms and definitions

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

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

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

### 3.1

#### **compacted (vermicular) graphite cast iron**

cast material, iron and carbon based, the carbon being present mainly in the form of compacted (vermicular) graphite particles that appear vermicular on a two-dimensional plane of polish, the graphite particles being embedded in a matrix consisting of ferrite, ferrite/pearlite, or pearlite

Note 1 to entry: Annex B provides typical compacted (vermicular) graphite cast iron microstructures.

### 3.2

#### **graphite modification treatment**

operation that brings the liquid iron into contact with a substance to produce graphite in the predominantly compacted (vermicular) form during solidification

### 3.3

#### **nodularity**

percentage of spheroidal graphite particles (forms V and VI according EN ISO 945-1)

Note 1 to entry: Graphite particles in compacted (vermicular) graphite cast irons are predominantly of form III.

**prEN 16079:2020 (E)**

Note 2 to entry: A technique for evaluating the nodularity of compacted (vermicular) graphite cast irons is described in Annex B.

**3.4****cast sample**

quantity of material cast to represent the cast material, including separately cast sample, side by side cast sample and cast-on sample

**3.5****separately cast sample**

sample cast in a separate sand mould under representative manufacturing conditions and material grade

**3.6****side-by-side cast sample**

sample cast in a mould alongside the casting, with a joint running system

**3.7****cast-on sample**

sample attached directly to the running system or the casting

**3.8****sample cut from a casting**

sample cut from an individual casting, by agreement between the manufacturer and the purchaser

**3.9****relevant wall thickness**

wall thickness representative of the casting, defined for the determination of the size of the cast samples to which the mechanical properties apply

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**4 Designation**

The material shall be designated either by symbol or by number as given in Table 1.

As a section sensitive material, Table 1 illustrates the wall thickness dependence of compacted (vermicular) graphite cast irons.

In the case of samples cut from the casting, the letter C is added at the end of the designation by symbol. In the case of test pieces prepared from separately cast samples, the letter "S" is added at the end of the grade designation. In the case of test pieces prepared from side-by-side or cast-on samples, the letter "U" is added at the end of the grade designation.

NOTE The comparison of EN 16079 grade designations with the grades from the ISO standard for compacted (vermicular) cast irons, ISO 16112:2017 [3], is given in Annex E.

**5 Order information**

The following information shall be supplied by the purchaser:

- a) the number of this European standard;
- b) the designation of the material;
- c) the relevant wall thickness;
- d) mechanical properties and their values (7.4);

- e) the type and size of cast samples, based on relevant wall thickness and load case from design (7.4).  
If samples cut from a casting are required, the location(s) of sampling in the casting;
- f) the location of sampling for metallographic investigation (7.6);
- g) any special requirements.

All requirements shall be agreed between the manufacturer and the purchaser by the time of acceptance of the order e.g. technical delivery conditions according to EN 1559-1 and EN 1559-3.

## 6 Manufacture

The method of manufacture of compacted (vermicular) graphite cast irons and its chemical composition shall be left to the discretion of the manufacturer. The manufacturer shall ensure that the requirements are met for the material grade specified in the order.

When compacted (vermicular) graphite cast irons are to be used for special applications, the chemical composition and heat treatment can be agreed upon between the manufacturer and the purchaser.

## 7 Requirements

### 7.1 General

The property values apply to compacted (vermicular) graphite cast irons cast in sand moulds or moulds of comparable thermal behaviour. Subject to an agreement between the manufacturer and the purchaser, castings can be obtained by alternative methods.

The material designation is based on the minimum mechanical properties obtained in cast samples with a thickness or diameter of 25 mm. The designation is irrespective of the type of cast sample.

Mechanical properties are wall thickness dependent as shown in Table 1.

NOTE Tensile testing requires sound test pieces in order to guarantee pure uni-axial stress during the test.

### 7.2 Test pieces machined from separately cast samples

The minimum tensile properties of compacted (vermicular) graphite cast iron, determined using test pieces machined from separately cast samples according to Figure 1 and Figure 2 shall be as specified in Table 1.

### 7.3 Test pieces machined from side-by-side and cast-on samples

The minimum tensile properties of compacted (vermicular) graphite cast iron, determined using test pieces machined from side-by-side cast samples according to Figure 1, Figure 2 or Figure 3 or to cast-on samples according to Figure 4, shall be as specified in Table 1.

## prEN 16079:2020 (E)

**Table 1 — Mechanical properties measured on test pieces machined from separately cast, cast side-by-side or cast-on samples**

Material designation		Relevant wall thickness	0,2 % proof strength	Tensile strength	Elongation
Symbol	Number	$t$ mm	$R_{p0,2}$ MPa min.	$R_m$ MPa min.	$A$ % min.
EN-GJV-300	5.2100	$12,5 < t \leq 30$	210	300	2,0
		$30 < t \leq 60$	195	275	2,0
		$60 < t \leq 200$	175	250	2,0
EN-GJV-350	5.2200	$12,5 < t \leq 30$	245	350	1,5
		$30 < t \leq 60$	230	325	1,5
		$60 < t \leq 200$	210	300	1,5
EN-GJV-400	5.2201	$12,5 < t \leq 30$	280	400	1,0
		$30 < t \leq 60$	260	375	1,0
		$60 < t \leq 200$	230	325	1,0
EN-GJV-450	5.2300	$12,5 < t \leq 30$	315	450	1,0
		$30 < t \leq 60$	280	400	1,0
		$60 < t \leq 200$	260	375	1,0

For relevant wall thicknesses greater than 200 mm, the manufacturer and the purchaser shall agree on the type and size of the cast sample and the minimum values to be obtained.

NOTE 1 The mechanical properties of test pieces machined from cast-on samples can be different from the properties of the casting itself, but usually give a better approximation than those obtained from separately cast samples. Additional values are given in Annex A for guidance.

NOTE 2 The percentage reduction in mechanical properties in thick sections depends upon the casting geometry and its cooling conditions.

**7.4 Test pieces machined from samples cut from a casting**

In many cases, Samples obtained directly from the casting better represent the properties of the casting itself than cast samples. If applicable, the manufacturer and the purchaser shall agree on:

- the location(s) on a casting where the sample(s) shall be taken;
- the mechanical properties that shall be determined;
- the values of these mechanical properties (for information, see Annex C).

NOTE 1 The properties of castings can vary, depending on the complexity of the castings and variation in their section thickness and cooling rates.

NOTE 2 Mechanical properties for test pieces cut from a casting are affected not only by material properties (subject of this document) but also by the local casting soundness (not subject of this document).