



## **R1 78 40 02 Technical Directive**

Inspection specifications for cast iron

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Intended for the Location IJmuiden

This is a non-registered document.

In case of any future changes, amendments will not be sent to you.

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# 1. GENERAL

## 1.1. Scope

This Technical Directive has been set up for the purpose of establishing general requirements and methods of inspection for all cast irons, ordered either directly through Corus Staal B.V. or through third parties. This Technical Directive is a partial elaboration of, and a continuation of instructions pertaining to article 6 of the Terms and Conditions of Delivery of Corus Staal B.V.

## 1.2. Definitions

The following definitions are applicable in this Technical Directive:

- Supplier/manufacturer: The foundry that produces the castings
- Customer: Corus Staal B.V.

Furthermore, in the event that a third party places an order at a supplier for castings destined to be used by Corus, within the framework of this Technical Directive, Corus is, and will always continue to be considered as the customer.

- The customer's inspection service: The inspection apparatus of the quality control department of Corus Staal B.V., or a similar inspection body appointed by Corus Staal B.V. to carry out such inspection activities.
- Ordered unit: A shipment, comprising one or more items of the same steel grade, that is ordered at the same time, or practically the same time.
- Inspection unit: A shipment, comprising one or more items of the same steel grade, for which the results of a prescribed inspection, with respect to its/their acceptance or rejection, is applicable.

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## 2. CAST IRONS

All cast irons are designated by material symbols and/or numbers. The explanation for the symbols and numbers is laid out in NEN-EN 1560. This directive is applicable to:

- a) Standardized cast iron: cast iron that is specified in a European standard.
- b) Non standardized cast iron that is not specified in a European standard, but is produced and/or used in CEN members.

This Technical Directive is applicable for all cast irons, such as:

- Grey cast iron NEN-EN 1561
- Malleable cast iron NEN-EN 1562
- Spheroidal graphite cast iron NEN-EN 1563
- Austempered ductile cast iron NEN-EN 1564

All the different types of cast iron are given in tabular form in chapter 3.

### 2.1. Manufacture

Unless it is otherwise specified, the supplier is free to determine the method of manufacture. This means that the shape of the patterns depends on the method of manufacture. Chaplets are only allowed if the customer extends permission for their use.

### 2.2. Appearance

When delivered, unmachined castings must be free of feeders, risers, and fins. The decision whether or not to remove feeder heads must be agreed during the ordering phase. The surface must be sound, smooth, and well cleaned.

**Without consultation with the customer, a casting may not be welded.**

Generally speaking, a defect may not be repaired unless this is first discussed and approved by the customer's inspection service.

The shape of a casting must, as far as is possible, correspond with the pattern or drawing on the basis of which it was originally ordered. Deviations from the drawing that may be necessary or desirable for moulding and casting purposes, can only be carried out by the supplier after consultation with, and approval from, the customer. The level of accuracy attained during the manufacture of a casting is, amongst other factors, dependent on the shape and construction of the casting itself. **It is not possible to give generally applicable values. The level of dimensional accuracy must be agreed upon during the ordering phase.** During this phase the customer must indicate which points of attachment or surfaces are to be used for the initial machining operation, and what the subsequent machining steps are to be.

Machining allowances may not be used to compensate for dimensional deviations, but are to be used to add extra allowance to the dimension in question. The amount of machining allowance can be agreed upon when the order is placed.

### 2.3. Mandatory information to be supplied by the customer

The following details must be defined by the customer  
(in accordance with NEN-EN 1559 standards)

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- number of castings
- casting material and material standard
- specifications (drawings, other standards)
- the supply of patterns, core boxes, metal moulds
- internal and external conditions
- machining allowance (in accordance with ISO 5459)
- general tolerances (in accordance with ISO 8062)
- the position of the test piece (cast-on test pieces or separately cast test pieces)
- the non-destructive testing method (acceptability criteria)
- the type of inspection (in accordance with EN 10204) and certificate

## 2.4. Inspection requirements

- a) If the casting does not have to comply with any specific requirements (such as the provision of covers or other simple component parts that do not have intricate shapes or do not have to withstand loads), a certificate of compliance with the order (2.1 in accordance with EN 10204) or a test report (2.2 in accordance with EN 10204) will suffice. If the latter is applicable, the customer must indicate which properties of the casting are to be reflected in the test results in this document (usually the chemical analysis).
- b) If the casting has to comply with certain strength requirements or if it has a complicated shape, an inspection certificate will have to be ordered (3.1B or 3.1C in accordance with EN 10204). This means that the requirements made on the casting as given in the order will have to be verified, such as:
  - cast-on test pieces or separately cast test pieces or test pieces taken from the casting
  - tensile strength (if the tensile strength is to be 400 N/mm<sup>2</sup> or higher, it must always be accompanied by a 3.1C certificate)
  - hardness
  - impact resistance test
  - chemical analysis
  - non-destructive test (indicate which class)
  - number of test pieces per inspection unit

## 2.5. Non-destructive testing

This type of test is only necessary if it is specified in the order or indicated on the drawing. However, if after carrying out a visual inspection there is reason enough to suspect the presence of defects, or following a repair, the customer will also be entitled to demand a supplementary non-destructive test as detailed below to be carried out. The customer will indicate the areas to be tested.

A basic assumption is that the presence of cracks is never acceptable.

### 2.5.1. Testing for surface cracks

If this inspection is required, the indicated areas will, for example, be inspected by means of:

- the magnetic method
- the dye penetration method

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The choice of the method to be followed, as well as the method chosen to carry it out, is subject to the approval of the customer.

### 2.5.2. *Testing for internal defects*

If this inspection is required, the indicated areas will be inspected by means of:

- *Ultrasonic testing*, in accordance with a method commonly used by the supplier, and which is submitted to the customer beforehand for approval.
- *Radiographic testing* in accordance with a method approved by the customer.
- The approval class(es) must be specified by the customer in the order or indicated on the drawing.
- *Pressure tightness*, in which in principle the provisions in DIN 50104 will be adhered to, and if necessary supplemented with additional details in the technical specification.

### 2.5.3. *Reporting*

The results of the inspections/tests, which must be carried out by persons qualified to do so, must be documented in a certificate by the supplier, and this certificate must be presented to the customer's inspection service immediately after the inspection/test. This certificate must contain at least the following details:

- the inspection/testing method
- the place(s) and extent of the inspection/test and, if applicable, including a sketch
- the method of determining the size of the defects and of the execution of the inspection/test, including the specification of the equipment used, type and strength of (electric) current, frequency, probes, dye liquids, pressures, etc.
- the rejection criteria (if necessary, including the specification of the place on the casting) with respect to the nature, number and size of the defects.
- the results of the inspection/test
- the specification, if applicable, of any repair methods used to redress unacceptable defects
- the results of any repeat inspections/tests
- all other relevant details that could be of importance to the applicable non-destructive test. It can also be determined beforehand that the customer's inspection service will be present during the execution of the inspection/test.

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### 3. TABLES

**Table 1 Types of grey cast iron**

Material designation		Relevant wall thickness 1)		Tensile strength $R_m^{2)}$ Mandatory values		Tensile str $R_m^{4)}$ Expected values in casting <sup>5)</sup>	Old design ation
Symbol	Number	mm		Separately cast test piece Test piece <sup>3)</sup> N/mm <sup>2</sup>	Cast-on test piece N/mm <sup>2</sup> min.	N/mm <sup>2</sup> min.	
		greater than	up to incl				
<b>EN-GJL 100</b>	EN-JL1010	5 <sup>6)</sup>	40	<b>100 to 200<sup>7)</sup></b>	-	-	GG 15
<b>EN-GJL-150</b>	EN-JL1020	2.5 <sup>6)</sup> 5 10 20 40 80 150	5 10 20 40 80 150 300	<b>150 to 250<sup>7)</sup></b>	- - - 120 110 100 90 <sup>5)</sup>	180 155 130 110 95 80 -	
<b>EN-GJL-200</b>	EN-JL1030	2.5 <sup>6)</sup> 5 10 20 40 80 150	5 10 20 40 80 150 300	<b>200 to 300<sup>7)</sup></b>	- - - 170 150 140 130 <sup>5)</sup>	230 205 180 155 130 115 -	GG 20
<b>EN-GJL-250</b>	EN-JL1040	5 <sup>6)</sup> 10 20 40 80 150	10 20 40 80 150 300	<b>250 to 350<sup>7)</sup></b>	- - 210 190 170 160 <sup>5)</sup>	250 225 195 170 155 -	GG 25
<b>EN-GJL-300</b>	EN-JL1050	10 <sup>6)</sup> 20 40 80 150	20 40 80 150 300	<b>300 to 400<sup>7)</sup></b>	- 250 220 210 190 <sup>5)</sup>	270 240 210 195 -	GG 30
<b>EN-GJL-350</b>	EN-JL1060	10 <sup>6)</sup> 20 40 80 150	20 40 80 150 300	<b>350 to 450<sup>7)</sup></b>	- 290 260 230 210 <sup>5)</sup>	315 280 250 225 -	GG 35

- 1) If a cast-on cast test piece has to be used, the relevant wall thickness must be agreed upon during the ordering phase.
- 2) If, during the ordering phase, it is agreed that the tensile strength has to be proven, the type of test piece also has to be specified in the order (refer to 8.2). If the type of test piece is not specified as part of the order, this will be left to the discretion of the manufacturer.
- 3) For the sake of acceptability, the tensile strength of a given type of casting must be between its nominal value  $n$  (position 5 of the material symbol) and  $(n+100)$  N/mm<sup>2</sup>.
- 4) If a casting with a simple shape and uniform wall thickness is poured with a certain type of grey cast iron, this column gives a guideline for the probable variation in tensile strength for different relevant wall thicknesses. For castings that do not have a uniform wall thickness or castings with core holes, the values given in the table only represent an approximate guide as to the probable tensile strength in different parts and the design of the castings should be based on measured tensile strength in critical parts of the casting.
- 5) These values are meant to serve as a guideline. They are not mandatory.
- 6) This value is included as a lower limit of the representative wall thickness.
- 7) The values as they apply to test pieces with a 30 mm diameter as poured; this corresponds with a relevant wall thickness of 15 mm.

**REMARKS**

- 1) 1 N/mm<sup>2</sup> is equivalent to 1 MPa
- 2) For a high absorptional capacity and thermal conductivity EN-GL-100 (EN-JL1010) is the most suitable material.
- 3) The material designation is in accordance with EN 1560.
- 4) The figures printed in bold indicate the minimum tensile strength for the material to which the symbol relates.

## Types of malleable cast iron

**Table 2 Whiteheart malleable cast iron (old designation: GSmF)**

Material designation		Nominal diameter of the test piece <i>d</i> mm	Tensile strength <i>R<sub>m</sub></i> N/mm <sup>2</sup> min.	Elongation <i>A<sub>3,4</sub></i> % min.	0,2% proof stress <i>R<sub>p0,2</sub></i> N/mm <sup>2</sup> min.	Brinell hardness (for information only)  HB max.
Symbol	Number					
EN-GJMW-350-4	EN-JM1010	6	270	10	- <sup>1)</sup>	230
		9	310	5	-	
		<b>12</b>	<b>350</b>	<b>4</b>	-	
		15	360	3	-	
EN-GJMW-360-12 <sup>2)</sup>	EN-JM1020 <sup>2)</sup>	6	280	16	- <sup>1)</sup>	200
		9	320	15	170	
		<b>12</b>	<b>360</b>	<b>12</b>	<b>190</b>	
		15	370	7	200	
EN-GJMW-400-5	EN-JM1030	6	300	12	- <sup>1)</sup>	220
		9	360	8	200	
		<b>12</b>	<b>400</b>	<b>5</b>	<b>220</b>	
		15	420	4	230	
EN-GJMW-450-7	EN-JM1040	6	330	12	- <sup>1)</sup>	220
		9	400	10	230	
		<b>12</b>	<b>450</b>	<b>7</b>	<b>260</b>	
		15	480	4	280	
EN-GJMW-550-4	EN-JM1050	6	-	-	- <sup>1)</sup>	250
		9	490	5	310	
		<b>12</b>	<b>550</b>	<b>4</b>	<b>340</b>	
		15	570	3	350	

<sup>1)</sup> Because of the difficulty in determining the proof stress of small test pieces, the customer and manufacturer must agree upon the values and measuring method during the ordering phase.  
<sup>2)</sup> The most suitable material for welding.

REMARKS:  
1) 1 N/mm<sup>2</sup> is equivalent to 1 MPa  
2) The material designation is in accordance with EN 1560  
3) The figures printed in bold indicate the minimum tensile strength and the minimum elongation *A<sub>3,4</sub>* for the type of material designated by the applicable symbol, and the desired nominal diameter of the test piece and the corresponding minimum 0,2% proof stress.

**Table 3 Blackheart malleable cast iron (old designation: GSMT)**

Material designation		Nominal diameter of the test piece <sup>1)</sup> <i>d</i> mm	Tensile strength <i>R<sub>m</sub></i> N/mm <sup>2</sup> min.	Elongation <i>A<sub>3,4</sub></i> % min.	0,2% proof stress <i>R<sub>p0,2</sub></i> N/mm <sup>2</sup> min.	Brinell hardness (for information only)  HB
Symbol	Number					
EN-GJMB-300-6 <sup>2)</sup>	EN-JM1110 <sup>2)</sup>	12 or 15	300	6	-	150 max.
EN-GJMB-350-10	EN-JM1130	12 or 15	350	10	200	150 max.
EN-GJMB-450-6	EN-JM1140	12 or 15	450	6	270	150 tot 200
EN-GJMB-500-5	EN-JM1150	12 or 15	500	5	300	165 tot 215
EN-GJMB-550-4	EN-JM1160	12 or 15	550	4	340	180 tot 230
EN-GJMB-600-3	EN-JM1170	12 or 15	600	3	390	195 tot 245
EN-GJMB-650-2	EN-JM1180	12 or 15	650	2	430	210 tot 260
EN-GJMB-700-2	EN-JM1190	12 or 15	700	2	530	240 tot 290
EN-GJMW-800-1	EN-JM1200	12 or 15	800	1	600	270 tot 320

<sup>1)</sup> Where a 6 mm diameter test piece is representative of the relevant wall thickness of a casting, this size of the test piece may be used in accordance with the agreement made between the manufacturer and customer during the ordering phase. The minimum properties given in this table will be applicable.  
<sup>2)</sup> Material specifically intended for applications in which the pressure tightness is more important than a high degree of strength and ductility.

REMARKS:  
1) 1 N/mm<sup>2</sup> is equivalent to 1 MPa.  
2) The material designation is in accordance with EN 1560.  
3) The figures printed in bold indicate the minimum tensile strength and the minimum elongation *A<sub>3,4</sub>* of the material type.

**Tabel 4**  
**Types of spheroidal graphite cast iron (with the properties of cast-on test pieces)**  
**(old designation GGG or GGN)**

Material designation		Relevant wall thickness $t$ mm	Tensile strength $R_m$ N/mm <sup>2</sup> min.	0,2% proof stress $R_{p0,2}$ N/mm <sup>2</sup> min.	Elongation $A$ % min.
Symbol	Number				
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-350-22U-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-350-22U-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	$t \leq 30$	450	310	10
		$30 < t \leq 60$	To be agreed between manufacturer and customer		
		$60 < t \leq 200$	To be agreed between manufacturer and customer		
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 manufacturer and customer		
		$60 < t \leq 200$	To be agreed between manufacturer and customer		
EN-GJS-900-2U	EN-JS1122	$t \leq 30$	900	600	2
		$30 < t \leq 60$	To be agreed between manufacturer and customer		
		$60 < t \leq 200$	To be agreed between manufacturer and customer		

<sup>1)</sup> LT for low temperature  
<sup>2)</sup> RT for ambient temperature.

REMARK 1  
The properties of cast-on test pieces cannot exactly reflect the properties of the casting itself but can nonetheless give a better approximation than that which can be achieved with a separately cast test piece. Further reference values are given in appendix D.

REMARK 2  
1 N/mm<sup>2</sup> = 1 MPa

REMARK 3  
The material designation is in accordance with EN 1560.

## Table 5 Types of austempered ductile cast iron

Mechanical properties (of test pieces) measured on separately cast test pieces

Material designation		Tensile strength	0,2% proof stress	Elongation
Symbol	Number	$R_m$ N/mm <sup>2</sup> min.	$R_{p0,2}$ N/mm <sup>2</sup> min.	$A$ % min.
EN-GJS-800-8	EN-JS1100	800	500	8
EN-GJS-1000-5	EN-JS1110	1000	700	5
EN-GJS-1200-2	EN-JS1120	1200	850	2
EN-GJS-1400-1	EN-JS1130	1400	1100	1
<p>REMARK 1 The values of these materials are applicable to castings cast in sand moulds with comparable thermal properties. Depending on the agreed supplements to the order, these values can also be applicable to castings manufactured using other methods of casting.</p> <p>REMARK 2 Irrespective of the method used for the manufacture of the castings, the types are based on the mechanical properties measured from separately cast test pieces using a sand mould or a mould with comparable thermal properties.</p> <p>REMARK 3 1 N/mm<sup>2</sup> = 1 MPa.</p> <p>REMARK 4 The material designation is in accordance with EN 1560.</p>				

### Remark

In any agreement pertaining to the properties of cast-on test pieces, the end of the material designation with symbols must be followed by the letter U and the last digit of the material number must be a 2.

The properties of cast-on test pieces cannot exactly reflect the properties of the casting itself, but can nonetheless give a much better approximation than that which can be achieved with separately cast test pieces.

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## 4. REFERENCES

In this Technical Directive reference is made to:

Terms and Conditions of Delivery of Corus Staal, article 6

NEN-EN

1559  
1560  
1561  
1562  
1563  
1564

ISO

5459  
8062

EN 10204

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## 5. STATEMENT

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