

# W9 Grey iron castings or flake graphite iron castings

(1978)  
(Rev.1  
1995)  
(Rev.2  
May 2004)  
(Complete  
Revision,  
Rev.3  
Feb 2025)

## 1 Scope

1.1 Grey iron castings or flake graphite iron castings (hereafter referred to as Grey iron casting) when required by the applicable construction Rules, are to be manufactured and tested in accordance with the requirements of the following paragraphs.

1.2 Alternatively, castings which comply with national/international standards or proprietary specifications may be accepted provided such specifications give reasonable equivalence to these requirements or may be specially approved by the individual Classification Society.

1.3 These requirements are applicable to unalloyed and low-alloyed grey iron casting grades.

1.4 Where small castings are produced in large quantities, the manufacturer may adopt alternative procedures for testing and inspection subject to the approval of the individual Classification Society.

1.5 These requirements cover grades of grey iron castings classified on the basis of tensile strength measured on tensile test specimen prepared from separately cast, side-by-side cast test blocks or cast-on test blocks.

1.6 When castings are intended for high temperature application, additional testing at the design temperature may be required when specially agreed with the individual Classification Society.

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### Note:

1. Rev.3 of this UR is to be uniformly implemented by IACS Societies to ships contracted for construction on or after 1 January 2027.
  2. The “contracted for construction” date means the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder. For further details regarding the date of “contract for construction”, refer to IACS Procedural Requirement (PR) No. 29.
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## 2 Manufacture

2.1 All relevant castings are to be made at foundries where the manufacturer has demonstrated to the satisfaction of the Classification Society that the necessary manufacturing and testing facilities are available and are supervised by qualified personnel. A programme of approval tests shall be required in accordance with the procedures of individual Classification Societies.

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2.2 Suitable mechanical methods are to be employed for the removal of surplus material from castings in accordance with recognised good practice. Thermal cutting processes such as flame cutting, scarfing or air-arc gouging are not acceptable, except as a preliminary operation to mechanical methods.

2.3 Where castings of the same type are regularly produced in quantity, the manufacturer is to make any tests necessary to prove the quality of the prototype castings and is also to make periodical examinations to verify the continued efficiency of the manufacturing technique as permitted under paragraph 1.4. The Surveyor is to be given the opportunity to witness these tests.

**3 Quality of castings**

3.1 Castings are to be free from surface or internal defects which would be prejudicial to their proper application in service. The surface finish is to be in accordance with good practice and any specific requirements of the approved plan.

**4 Chemical composition**

4.1 The chemical composition of the grey cast iron is left to the discretion of the manufacturer, unless otherwise specified by the individual Classification Society for specific applications. The manufacturer shall ensure that the chosen chemical composition is suitable to obtain the mechanical properties specified for the castings grade. When required by individual Classification Societies the chemical composition of ladle samples is to be reported.

**5 Heat treatment**

5.1 Except as required by 5.3 castings may be supplied in either the as cast or heat treated condition.

5.2 The delivery condition shall meet the design and application requirements. It is the manufacturers responsibility to select the appropriate heat treatment method and cycle, The description of the entire heat treatment method and cycle is to be submitted to the Classification Society, including any surface hardening.

5.3 Castings for components such as engine blocks, where dimensional stability and freedom from residual stresses are important, may require to be given a stress relieving heat treatment. The manufacturer shall control the temperature in order to avoid any detrimental effects to the microstructure and mechanical properties of the casting.

5.4 Where heat treatment is required, it is to be carried out in properly constructed furnaces which are efficiently maintained, subjected to regular temperature uniformity survey and have adequate means for control and recording of temperature. The furnace dimensions are to be such as to allow the whole casting to be uniformly heated to the necessary temperature. In the case of very large castings alternative methods for heat treatment will be specially considered by the individual Classification Society.

5.5 Records of heat treatment of each casting or batch of castings shall be maintained by the manufacturer and are to be presented to the Surveyor on request.

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## 6 Mechanical tests

6.1 Test material sufficient for the required tests and for possible re-tests is to be provided for each casting or batch of castings.

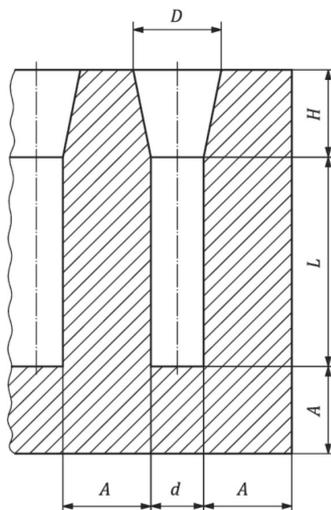
6.2 Separately cast test blocks, or side-by-side test blocks are used unless otherwise agreed between the manufacturer and purchaser and generally are to be in the form of uniform cylindrical bars 30 mm in diameter and of a suitable length (Fig 1. Type II). Alternatively, cast test blocks of other types (See Fig 1: Type I, III and IV) may be specified based on the relevant wall thickness of the casting and when agreed between the manufacturer and purchaser.

Note:

1. Separately cast test blocks: Test blocks cast in a separate sand mould under representative manufacturing conditions and material.
2. Side-by-side cast test blocks: The test block is cast in the mould alongside the castings, with a connected running system.
3. Relevant wall thickness: Section of the casting, agreed between the manufacturer and the purchaser, to which the determined mechanical properties apply.

6.3 Separately cast test blocks shall be cast from the same ladle and in a mould material with comparable thermal behaviour as the castings they represent. The cast test blocks are not to be stripped from the moulds until the metal temperature is below 500°C.

Note: For side-by-side test blocks, when mechanical properties are required for a series of castings belonging to the same test unit, the cast blocks shall be produced in the last moulds poured.



Test block types	Dimensions, mm					Preferred diameter of tensile test specimen, mm
	d (+2/-0)	L	D (±5)	H	A	
Type I	15	A function of the test specimen length	40	≥40	≥40	10
Type II	30		50	≥50	≥50	20
Type III	45		70	≥60	≥60	32
Type IV	75		105	≥90	≥90	32

Figure 1 Separately cast or Side-by-side test blocks

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6.4 Subject to agreement between the manufacturer and the purchaser, cast-on test blocks may be used when a casting is more than 20 mm wall thickness and its mass exceeds 200 Kg. The type and location of the cast-on test blocks are to be selected to provide approximately the same cooling conditions as for the casting it represents. The cast-on test blocks shall have a general shape as indicated in either Fig. 2-Type 1 or Type 2 with the corresponding dimensions. The length L (see Fig. 2-Type 1 and Type 2) shall be determined according to the tensile test specimen length and the gripping arrangement.

Note:

- Two possible sets of sizes are shown in Fig. 2-Type 1 and Type 2, with the larger test block size option shown in brackets. The small-size set is used for castings of wall thickness < 100 mm, and the large-size set is used for castings of wall thickness  $\geq 100$  mm. The choice of the cast-on test block type (Fig. 2-Type 1 or Type 2) shall be agreed upon between the manufacturer and the purchaser.
- Cast-on test blocks: Test blocks attached directly to the casting.

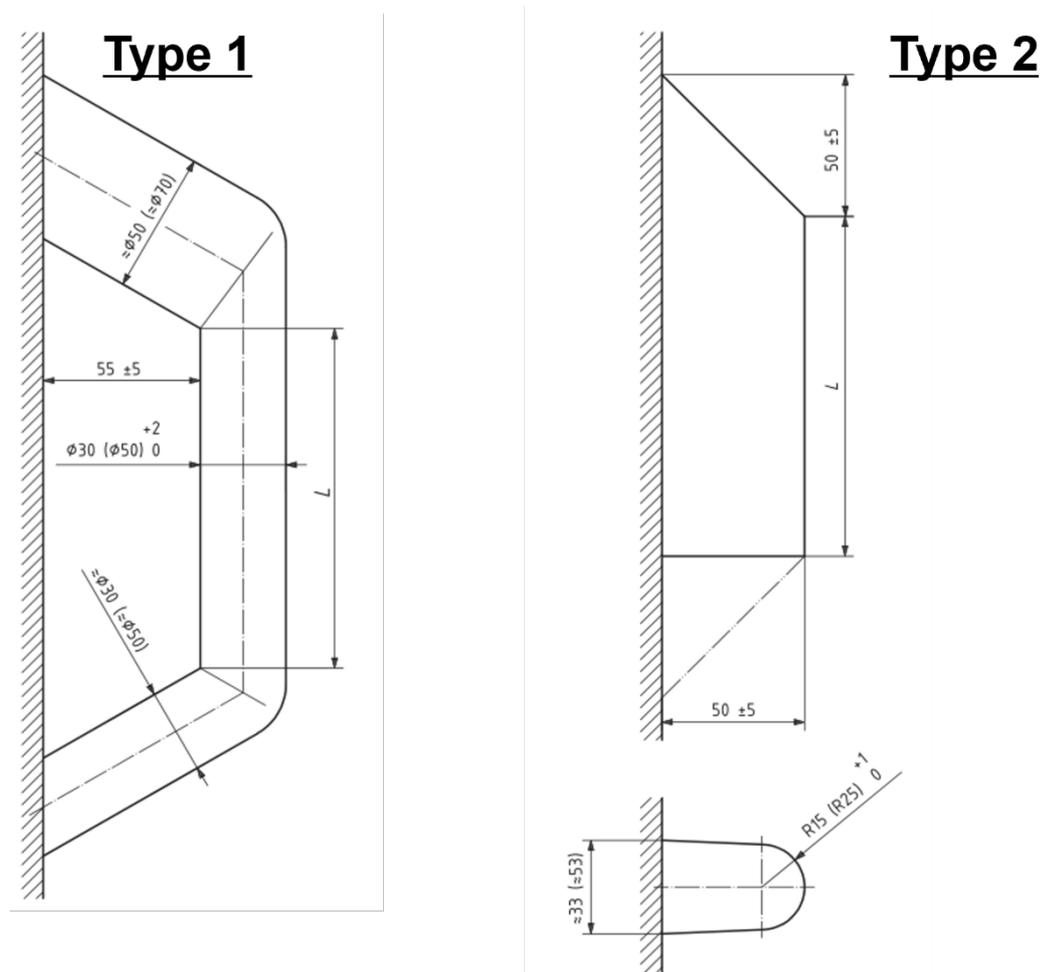


Figure 2 Cast-on test block -Type 1 and Type 2 (Dimensions in mm)

6.5 With the exception of 6.8, at least one test block is to be cast with each batch.

6.6 With the exception of 6.7, a batch consists of the castings poured from a single ladle of metal, provided that they are all of similar shape and dimensions. A batch should not

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normally exceed two tonnes of fettled castings (castings with the feeding and running systems removed) and a single casting will constitute a batch if its mass exceeds 2 tonnes.

6.7 For continuous melting of the same grade of cast iron in large tonnages the mass of a batch may be increased to the output of 2 hours of pouring. The minimum number of test blocks to be provided shall be one tensile test representing every 2 hours of production from the melting furnace.

6.8 If the same grade of cast iron is melted in large quantities and, a system controlled melting technology with strict production process control are adopted, and where appropriate inspection such as chill testing, chemical analysis or thermal analysis are carried out for each heat, then test blocks may be taken at longer intervals. This should be subject to agreement between the manufacturer, the purchaser and the Classification Society. Where a national/international standard is being applied, then the frequency specified in the reference standard should not be reduced.

6.9 All test blocks are to be suitably marked to identify them with the castings which they represent.

6.10 Where castings are supplied in the heat treated condition, the test blocks are to be heat treated together with the castings which they represent. For cast-on test blocks, the block shall not be cut off from the casting until after the heat treatment.

6.11 One tensile test specimen is to be prepared from each cast test block and the 30mm diameter cylindrical test bar is to be machined to the dimensions given in UR W2. Where test blocks of other dimensions are specially required the tensile test specimens are to be machined to the dimensions shown in Fig 1 of UR W9.

6.12 All tensile tests are to be carried out using test procedures in accordance with UR W2. Unless otherwise agreed all tests are to be carried out in the presence of the Surveyors.

## **7 Mechanical Properties**

7.1 Table 1 gives the tensile strength requirements for grey cast iron grades measured on test specimens machined from either separately cast test blocks (including side-by-side test blocks) or cast-on test blocks.

7.2 Only the tensile strength is to be determined and the results obtained from tests are to comply with the requirements of the specified grades as shown in Table 1. The value selected for the specified minimum tensile strength is to be not less than 200 N/mm<sup>2</sup> but subject to any additional requirements of the relevant construction Rules. The fractured surfaces of all tensile test specimens are to be granular and grey in appearance.

7.3 Re-test requirements for tensile tests are to be in accordance with UR W2.

7.4 When the test specimen failure is attributable to flaw, cavity and other detrimental casting defects, or defective test specimen due to incorrect pouring or machining, then the results of the test may be discarded, and a further test conducted on the spare test specimen.

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**Table 1. Tensile strength determined on test specimens machined from cast test blocks.**

Material grade	Relevant wall thickness $t$ , mm (Note 1)		Tensile strength, N/mm <sup>2</sup> (Note 4)		
			Values applicable to Fig 1. Type II test blocks only (Note 2)		Cast-on test blocks (Note 3)
			$\geq$	$\leq$	
200	$\geq$ 2.5	< 5	200	300	-
	5	10			-
	10	20			-
	20	40			170
	40	80			155
	80	150			140
	150	300			130
225	5	10	225	325	-
	10	20			-
	20	40			190
	40	80			170
	80	150			155
	150	300			145
250	5	10	250	350	-
	10	20			-
	20	40			210
	40	80			190
	80	150			170
	150	300			160
275	10	20	275	375	-
	20	40			230
	40	80			210
	80	150			190
	150	300			180
300	10	20	300	400	-
	20	40			250
	40	80			225
	80	150			210
	150	300			190
350	10	20	350	450	-
	20	40			290
	40	80			260
	80	150			240
	150	300			220

Note 1: For relevant wall thickness greater than 300mm, the manufacturer and the purchaser shall agree on the type and size of the cast sample and on the minimum required tensile strength value.

Note 2: For test block dimensions other than Fig. 1 Type II, the test block type and the minimum tensile value or range of tensile values to be obtained shall be agreed upon between the manufacturer, the purchaser and the Classification Society.

Note 3: The minimum tensile strength values are applicable to cast-on test blocks, where the relevant wall thickness for the casting has been agreed.

Note 4: If a particular type of test block is to be specified, a “/” is added to the designation, followed by a letter indicating the type of test block:

/S = separately cast test block or side-by-side cast test block.

/U = cast-on test block.

/C = sample cut from casting.

## 8 Inspection

8.1 All castings are to be cleaned and adequately prepared for examination; suitable methods include pickling, caustic cleaning, wire brushing, local grinding, shot or sand blasting. The surfaces are not to be hammered, peened or treated in any way which may obscure defects.

8.2 Visual inspection and verification of dimensions is the responsibility of the manufacturer. The visual examination is to include all external, and where applicable, internal surfaces. The castings shall be free from defects which are detrimental to practical use. The castings accepted by the manufacturer, and which are subject to certification by the Classification Society shall additionally be presented to the Surveyor for visual examination before final acceptance.

8.3 Supplementary examination of castings by suitable non-destructive testing methods is generally not required except in circumstances where there is reason to suspect the soundness of the casting.

8.4 When required by the applicable construction Rules or design code, castings are to be pressure tested before final acceptance. Where the product is to be certified by the Classification Society, the Surveyor is to be given the opportunity to witness these tests.

8.5 In the event of any casting proving defective during subsequent machining or testing it is to be rejected notwithstanding any previous certification.

## 9 Metallographic examination

9.1 When specified by the manufacturer, Classification Society, agreed national/international standard or the purchaser, the microstructure of grey iron castings shall be reported.

9.2 Unless otherwise specified by the individual Classification Society or the purchaser, the metallographic examination shall be carried out in accordance with recognised national or international standards (such as ISO 945-1:2019).

9.3 Unless otherwise specified, the microstructure shall be substantially free of primary cementite and massive steadite and shall consist of flake graphite in a matrix of ferrite and/or pearlite.

9.4 Unless otherwise specified, the graphite structure shall be primarily distribution (Form I) Type A in accordance with ISO 945-1:2019.

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(cont)**10 Rectification of defective castings**

10.1 Subject to agreement by the individual Classification Society, small surface blemishes may be removed by local grinding.

10.2 Subject to the prior approval of the individual Classification Society, castings containing local porosity may be rectified by impregnation with a suitable plastic filler, provided that the extent of the porosity is such that it does not adversely affect the strength of the casting.

10.3 Repairs by welding are generally not permitted unless specially agreed with the individual Classification Society.

**11 Identification of castings**

11.1 The manufacturer is to adopt a system of identification, which will enable all finished castings to be traced to the original cast. The Surveyor is to be given full facilities for so tracing the castings when required.

11.2 Before acceptance, all castings which have been tested and inspected with satisfactory results are to be clearly marked by the manufacturer. At the discretion of individual Classification Societies any of the following particulars may be required:

- (i) The material grade.
- (ii) Identification number, cast number or other marking which will enable the full history of the casting to be traced.
- (iii) Manufacturer's name or trade mark.
- (iv) The Classification Society's name, initials or symbol.
- (v) Abbreviated name of the Classification Society's local office.
- (vi) Personal stamp of Surveyor responsible for inspection.
- (vii) Where applicable, test pressure.
- (viii) Date of final inspection

11.3 Where small castings are manufactured in large numbers, modified arrangements for identification may be specially agreed with the Classification Society.

**12 Certification**

12.1 The manufacturer is to provide the required type of inspection certificate giving the following particulars for each casting or batch of castings which has been accepted:

- (i) Purchaser's name and order number.
- (ii) Description of castings
- (iii) Material grade
- (iv) Cast number or Identification number.
- (v) Results of mechanical tests.
- (vi) Where applicable, general details of heat treatment including temperatures and holding times.
- (vii) When specially required, the chemical analysis of ladle samples.
- (viii) Where applicable, test pressure.
- (ix) Visual inspections and where applicable, results of any additional non-destructive tests.
- (x) Where applicable, results of the metallographic examination

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