



Standard Specification for Abrasion-Resistant Cast Irons¹

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This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This specification covers a group of white cast irons that have been alloyed to secure high resistance to abrasive wear in the applications of the mining, milling, earth-handling, and manufacturing industries.

1.2 Simple and low-alloy white cast irons that consist essentially of iron carbides and pearlite are specifically excluded from this specification.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

2. Referenced Documents

2.1 *ASTM Standards*:²

E10 Test Method for Brinell Hardness of Metallic Materials

E18 Test Methods for Rockwell Hardness of Metallic Materials

E92 Test Method for Vickers Hardness of Metallic Materials (Withdrawn 2010)³

E350 Test Methods for Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron

E351 Test Methods for Chemical Analysis of Cast Iron—All Types

3. Ordering Information

3.1 Orders for material in this specification should include the following information:

¹ This specification is under the jurisdiction of ASTM Committee A04 on Iron Castings and is the direct responsibility of Subcommittee A04.01 on Grey and White Iron Castings.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ The last approved version of this historical standard is referenced on www.astm.org.

3.1.1 Quantity,

3.1.2 Specification number, class, and type,

3.1.3 Description of the casting, pattern number, or drawing,

3.1.4 Chilling of the casting, if required (see 4.2),

3.1.5 Heat treat condition (see 5.1),

3.1.6 Hardness level, if supplied hardened or hardened and stress relieved, and

3.1.7 Hardness method, Brinell, Rockwell, Vickers (see Section 9). If the hardness method is not specified, it shall be at the manufacturer's option.

4. Method of Manufacture

4.1 These alloys may be made by any suitable melting process.

4.2 If the casting is to be chilled or otherwise specially treated on any portion, the inquiries and the purchase order shall so state and a properly marked drawing of the casting will accompany both the inquiry and the purchase order.

5. Heat Treatment

5.1 The casting will be supplied in one of the following conditions:

5.1.1 As-cast,

5.1.2 As-cast and stress relieved,

5.1.3 Hardened,

5.1.4 Hardened and stress relieved, or

5.1.5 Softened for machining.

5.2 Unless otherwise specified by the purchaser, the manufacturer shall supply the castings in the heat treatment he deems best for the application.

5.3 If the heat treatment specified for delivered condition is not that of final use, it shall be the responsibility of the purchaser to provide the additional heat treatment.

5.4 Class II and Class III alloys are frequently ordered in the annealed condition with a maximum hardness of 400 HB. After machining operations are performed the castings may then be hardened. If both annealing and machining are to be performed by the manufacturer, as specified in the inquiry, contract, or order, the purchaser may then specify delivery in the hardened condition. If the purchaser specifies delivery in the annealed

condition, subsequent hardening (and stress-relief, if it is desired) is the responsibility of the purchaser.

6. Chemical Composition

6.1 The composition of the metal of a class and type produced under this specification shall fall within the ranges prescribed in **Table 1** for that class and type.

6.2 Spectrographic, X-ray, or wet chemical laboratory techniques are acceptable for routine and control determinations, but shall be standardized against, and give essentially the same results as, the umpire methods specified in **6.3** of this specification.

6.3 In case of dispute, umpire determinations of the chemical analysis of the metal shall be made using ASTM standard methods detailed as follows:

6.3.1 The following is in accordance with Test Methods **E351**:

6.3.1.1 Carbon, Total by the Combustion Gravimetric Method.

6.3.1.2 Chromium by the Peroxydisulfate-Oxidation Titrimetric Method.

6.3.1.3 Copper by the Sulfide Precipitation-Electrodeposition Gravimetric Method.

6.3.1.4 Manganese by the Peroxydisulfate-Arsenite Titrimetric Method.

6.3.1.5 Nickel by the Dimethylglyoxime Gravimetric Method.

6.3.1.6 Phosphorus by the Molybdenum Blue Photometric Method.

6.3.1.7 Sulfur by the Combustion-Iodate Titration Method.

6.3.2 The following is in accordance with Test Methods **E350**:

6.3.2.1 Molybdenum by the Photometric Method.

7. Microstructure

7.1 The alloys covered by this specification are expected to have microstructures that consist essentially of carbides, martensite, bainite, austenite; and in exceptional cases minor amounts of graphite or pearlite.

7.2 The microstructure will not be routinely determined nor reported except in accordance with special agreement between the manufacturer and the purchaser, or in cases of dispute.

8. Hardness Requirements

8.1 The castings shall conform to the hardness requirements specified in **Table 2**.

8.2 The hardness test shall be performed on the original surface of the casting or up to $\frac{1}{8}$ in. (3 mm) below that surface.

9. Hardness Method

9.1 Perform the hardness test in accordance with one of the following methods to be specified by the purchaser:

9.1.1 Test Method **E10** (Brinell) using a tungsten carbide ball and 3000 kgf load,

9.1.2 Test Method **E18** (Rockwell) using a diamond cone penetrator, 150 kgf load, and the Rockwell C Scale, or

9.1.3 Test Method **E92** (Vickers).

10. Quality

10.1 The surface of the casting shall be free of adhering sand, scale, cracks, and hot tears as determined by visual examination. Other surface discontinuities shall meet the visual acceptance standards specified in the order.

11. Keywords

11.1 abrasion resistant; alloyed cast iron; cast iron; white cast iron

TABLE 1 Chemical Requirements, Weight %

Class	Type	Designation	Carbon	Manganese	Silicon	Nickel	Chromium	Molybdenum	Copper	Phosphorus	Sulfur
I	A	Ni-Cr-Hc	2.8–3.6	2.0 max	0.8 max	3.3–5.0	1.4–4.0	1.0 max	...	0.3 max	0.15 max
I	B	Ni-Cr-Lc	2.4–3.0	2.0 max	0.8 max	3.3–5.0	1.4–4.0	1.0 max	...	0.3 max	0.15 max
I	C	Ni-Cr-GB	2.5–3.7	2.0 max	0.8 max	4.0 max	1.0–2.5	1.0 max	...	0.3 max	0.15 max
I	D	Ni-HiCr	2.5–3.6	2.0 max	2.0 max	4.5–7.0	7.0–11.0	1.5 max	...	0.10 max	0.15 max
II	A	12 % Cr	2.0–3.3	2.0 max	1.5 max	2.5 max	11.0–14.0	3.0 max	1.2 max	0.10 max	0.06 max
II	B	15 % Cr-Mo	2.0–3.3	2.0 max	1.5 max	2.5 max	14.0–18.0	3.0 max	1.2 max	0.10 max	0.06 max
II	D	20 % Cr-Mo	2.0–3.3	2.0 max	1.0–2.2	2.5 max	18.0–23.0	3.0 max	1.2 max	0.10 max	0.06 max
III	A	25 % Cr	2.0–3.3	2.0 max	1.5 max	2.5 max	23.0–30.0	3.0 max	1.2 max	0.10 max	0.06 max



TABLE 2 Hardness Requirements

Class	Type	Designation	Hardness Value-HB												Typical Section Thickness					
			As Cast or As Cast and Stress Relieved			Sand Cast, min ^A			Hardened or Hardened and Stress Relieved			Chill Cast, min ^B				Softened, max				
			HB	HRC	HV	HB	HRC	HV	HB	HRC	HV	HB	HRC	HV		HB	HRC	HV	HB	HRC
I	A	Ni-Cr-HfC	550	53	600	600	600	650	59	715	600	56	660	600	56	660	600	41	430	430
	B	Ni-Cr-LoC	550	53	600	600	650	59	715	600	56	660	600	56	660	600	41	430	430	
	C	Ni-Cr-GB	550	53	600	600	650	59	715	600	56	660	600	56	660	600	41	430	430	
	D	Ni-HfCr	500	50	540	600	650	59	715	550	53	600	53	600	550	53	600	41	430	430
II	A	12 % Cr	550	53	600	600	650	59	715	600	56	660	600	53	600	600	41	430	430	
	B	15 % Cr-Mo	450	46	485	600	650	59	715	600	56	660	600	53	600	600	41	430	430	
	D	20 % Cr-Mo	450	46	485	600	650	59	715	600	56	660	600	53	600	600	41	430	430	
III	A	25 % Cr	450	46	485	600	650	59	715	600	56	660	600	53	600	600	41	430	430	

^A 90 % of the minimum surface hardness level shall be maintained to a depth of 40 % of the casting section, with any softer material being at the thermal center of the casting. A sampling procedure should be established by agreement between the supplier and the purchaser.

^B Non-chilled areas of casting shall meet minimum hardness or sand cast requirements.



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