Designation: A367 – 11

Standard Test Methods of Chill Testing of Cast Iron[1]

This standard is issued under the fixed designation A367; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 These test methods of chill testing apply to gray irons that are to be free of chill in the casting and to chilled irons that are to have a specific depth of chill in the casting. Two test methods of determining the chilling tendencies of cast iron are covered as follows. For many applications either test method will be satisfactory if test pieces of the proper dimensions are selected.

1.1.1 *Test Method A, Wedge Test*—This test is generally better adapted to the higher strength gray irons. The accelerated cooling rate to induce the formation of a chill is brought about through the design of the test specimen. This test method is simpler than Test Method B since maintenance of chill blocks or plates is not necessary.

1.1.2 *Test Method B, Chill Test*—This test is better adapted to the softer grades of gray iron and should be used if the casting is to have a specified depth of chill. The chill in this type of test is induced by casting one edge of the test specimen against a metal or graphite chilled plate or block.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.2.1 The metric equivalency charts in Figs. 1 and 2 are provided for information only.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

TEST METHOD A—WEDGE TEST

2. Application

2.1 Selection of a test specimen of appropriate dimensions will allow measurement of chilling tendencies of all gray iron compositions, with the exception of those having silicon contents much over 2.50 % together with carbon contents over 3.50 %.

3. Test Specimens

3.1 The patterns for the test specimens shall be made of metal to the dimensions shown in Fig. 1. With the exception of the length of the test specimen, dimensions shall not vary more than ±1⁄32 in. (0.8 mm). The tolerance on the length of the specimen shall be ±1⁄8 in. (3.2 mm). The radius on the apex of the wedge should be formed by filing a 1⁄32-in. flat on the sharp edge of the metal pattern and then carefully rounding the edges formed by the 1⁄32-in. flat and the sides of the wedge. If draft on the pattern is desired, it may be obtained by varying dimension *H* (Fig. 1) from one end of the specimen to the other. The pattern should be mounted in a core box so that the final core can be poured with the wedge in such a position that its length is vertical. There shall be 1-in. (25.4-mm) minimum sand at the bottom of the core.

4. Procedure

4.1 *Cores*—Make the test in a core. The cores may be either single cores or gang cores. If a gang core is used, the minimum amount of sand between adjacent test specimens shall be not less than 2½ × *B* (Fig. 1). The sand cores shall be well cured and free of moisture. The base sand shall be of such fineness that a smooth casting will be obtained. A sand with an AFS fineness[2] of about 70 will be found satisfactory, although a sand with a fineness of 100 or finer may be used for the smaller test specimens.

4.2 *Pouring Practice*—Pour all samples at as consistent a pouring temperature as possible since the amount of chill is clearly affected by the pouring temperature. Take precautions to obtain a representative sample of iron for the test specimen. Best results are obtained with a sample ladle lined with a refractory mixture that is free of graphite and chilled iron. The ladle should hold at least 5 lb (2.3 kg) of iron in order to avoid excessive chilling of the iron before the test specimen can be poured. Filling the ladle once with iron just prior to obtaining the sample for test is recommended.

[1] These test methods are under the jurisdiction of ASTM Committee A04 on Iron Castings and are the direct responsibility of Subcommittee A04.21 on Testing.

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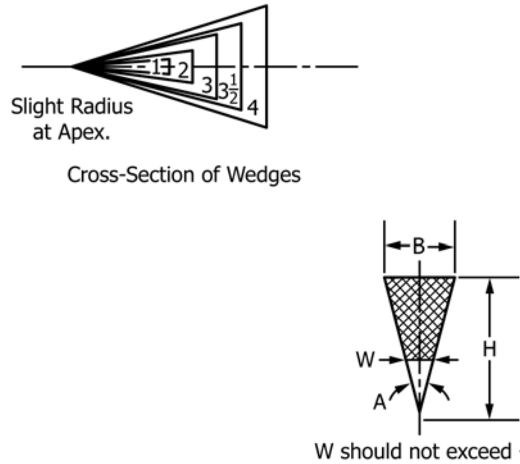
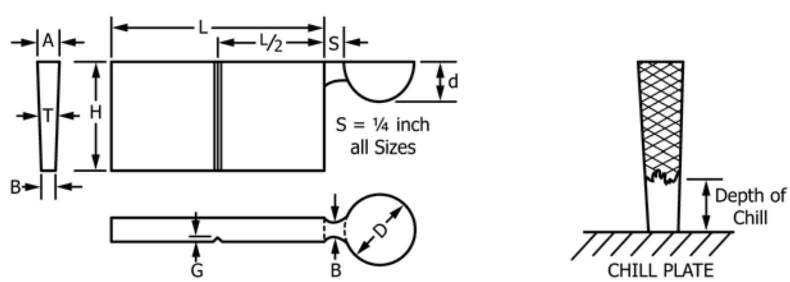
[2] *Mold & Core Test Handbook*, The American Foundry Society



Wedge No.	Wedge Dimensions						
	B		*H*		A, deg	Length	
	in.	mm	in.	mm		in.	mm
W 1	0.20	5.1	1.00	25.4	11.5	4	101.6
W 2	0.40	10.2	1.25	31.8	18	4	101.6
W 3	0.75	19.1	1.50	38.1	28	4	101.6
W 3½	1.00	25.4	1.75	44.4	32	5	127.0
W 4	1.25	31.8	2.00	50.8	34.5	6	152.4

FIG. 1 Dimensions for Test Wedges



Chill Test No.	Recommended Dimensions, in.								Recommended Chill Depth Range, 1⁄32 in.[A]
	T	*A*	*B*	*H*	*L*	*D*	*d*	*G*	
1C	3⁄16	¼	⅛	1¼	2½	¾	½	1⁄32	3 to 12
2C	¼	5⁄16	3⁄16	1½	3	⅞	½	1⁄32	4 to 16
3C	⅜	7⁄16	5⁄16	1¾	3½	⅞	½	1⁄16	6 to 24
4C	½	9⁄16	7⁄16	2	4	1	⅝	1⁄16	8 to 32
5C	¾	13⁄16	11⁄16	2½	5	1	⅝	3⁄32	12 to 48

[A] *T*/2 to 2*T*.

Note 1—Casting to be made in a dry sand core.

Note 2—Allow ¾ in. of sand on all sides.

Metric Equivalents

in.	mm	in.	mm	in.	mm
1⁄32	0.8	⅜	9.5	1	25.4
1⁄16	1.6	7⁄16	12.1	1¼	31.8
3⁄32	2.4	½	12.7	1½	38.1
⅛	3.2	9⁄16	14.3	1¾	44.4
3⁄16	4.8	11⁄16	17.5	2	50.8
¼	6.4	¾	19.0	2½	63.5
5⁄16	7.9	13⁄16	20.6		

FIG. 2 Recommended Dimensions for Test Method B Chill Test Specimens

4.3 *Cooling of Test Specimen*—If time is an important factor in control applications, the test specimen may be quenched in water as soon as it is completely solid. The quenching must be done carefully to avoid cracking of the chilled apex of the wedge. This may be accomplished by grasping the wedge with tongs at the apex of the wedge and immersing about ¼ to ½ in.

(6.4 to 12.7 mm) of the base of the wedge in water. The wedge may then be gradually quenched but should be removed while there is still sufficient heat in the wedge to dry off the water. If speed of testing is not important, the test specimen may be either cooled in the core or in the air. If cooled to a very dull red before quenching in water, the demarcation between the chilled iron and the gray iron is somewhat clearer than if the test specimen is quenched as soon as it is solid.

5. Measurement of Chill

5.1 Break the test specimen by striking with a hammer in such a manner that the fracture is straight and midway of its length. The chilled iron at the apex of the wedge with a few exceptions consists of two zones. That portion nearest the apex entirely free of any gray spots is designated as *clear chill.* That portion starting with the end of the clear chill and continuing to the location where the last spot of cementite or white iron is visible is designated as the *mottled zone.* The extent of the mottled zone may vary from virtually nothing to an amount equal to and even greater than the amount of the clear chill. If the wedge is measured at the junction of the gray fracture with the first appearance of chilled iron, the measurement shall be designated as *total chill.* In all cases, express the chill in 1⁄32 in. (0.8 mm) as measured across the wedge at the locations just described. The location of this measurement for a wedge having a narrow mottled zone is shown in Fig. 1. For structure control purposes, it is generally satisfactory to measure the wedge where the structure is approximately 50 % white iron and 50 % gray iron. This value will be found to be virtually the same as the average of the measurement of the clear chill measurement, designate the size of the test specimen. A chill reported as W3-12 would indicate that wedge W3 was used and the width at the junction of the chilled and gray portions of the fraction was 12⁄32 in. (9.5 mm).

TEST METHOD B—CHILL TEST

6. Application

6.1 This test method is better adapted than Test Method A to irons having silicon contents of 2.50 % and over and carbon contents of 3.50 % and over. It is also useful for control purposes in high-production foundries making irons somewhat lower in carbon and silicon than indicated above. This test method is also preferable for applications in which the casting is to have a specified depth of chill.

7. Test Specimens

7.1 The patterns shall be made of metal and conform to the dimensions shown in Fig. 2. All dimensions shall be within ±1⁄32 in. (0.8 mm) of those shown, with the exception of the length which may vary ± 1⁄8 in. (3.2 mm). The test specimens shown are designed to be cast in the position shown. This design is the preferred one, although for high-production work, a gang core box and pattern may be used. In this case, a test specimen with the chilled face in a vertical position may be found more convenient although it is not considered as satisfactory as the horizontally cast test specimen.

8. Procedure

8.1 *Cores*—Make the test in a core. For general application, a single core is considered more satisfactory than a gang core. If a gang core is used, the amount of sand between test specimens shall be 1 in. (25.4 mm) minimum or 2½ × *A* (Fig. 2), whichever is greater. The remarks concerning cores in 4.1 apply here also.

8.2 *Chill Plates*—Chill plates may be cast iron, steel, copper, or graphite. Machine the surface of the chill plate. When single test specimens are cast, the chill plate shall extend at least 1 in. beyond the test specimens in all directions and shall be at least 1-in. thick. For high-production work, a sufficient number of chill plates must be available to keep the temperature of the plate below 500°F (260°C). A water-cooled steel plate will be found more satisfactory for high-production work. A water-cooled plate having a reservoir is preferable to one having circulating water. In the latter case the plate may become too cold, resulting in condensation of moisture on the plate. The chill plate must be kept free of the fire cracks and all foreign matter as the depth of chill is markedly affected by the presence of films of burned oil or other accumulations. The best practice is to clean off the plate with a wire brush as soon as the core and test specimen are removed.

8.3 *Pouring Practice*—Remarks on pouring practice in 4.2 apply here. In addition, do not pour iron directly on the chill plate as the depth of chill may be affected or the test specimen may burn on the chill plate. It may be desirable to place a weight on the core when pouring it as there may be a tendency for the core to lift as it is being poured. The opening in the core shall be free of sand fins and shall set flat on the chill plate. In the event the core does not fit the chill plate, rub it until it does.

8.4 *Cooling of Test Piece*—The remarks in 4.3 apply here. If rapid testing is desired, the chill test specimen may be quenched in water, starting with the edge farthest from the chilled edge.

9. Measurement of Chill

9.1 Break the test specimen in such a manner that the fracture is straight and follows the notch in the test specimen. The chill from the chilled face to the first appearance of a gray spot shall be designated as *clear chill.* The distance from the chilled face to the last appearance of a spot of white iron shall be designated as *total chill.* That portion of the chill affected zone between the clear chill and the total chill shall be designated as the *mottled zone.* As in Section 5, it will be found satisfactory for general structure and quality control purposes to measure chill from the chilled face to a location where the structure is approximately 50 % white iron, which is roughly half-way through the mottled zone. If the chill test is used for the control of iron for castings having a chilled surface for wear-resistant purposes, it would be desirable to measure and record clear chill. If the casting with a chilled surface is to have some machining operation in the proximity of the chilled surface, it may also be necessary to specify maximum depth of total chill as well as depth of clear chill. In all cases, the depth of chill shall be expressed in 1⁄32 in. (0.8 mm) and the size of the test specimen used shall be designated. For example, a measurement recorded as 4C-12 indicates that test specimen design 4C was used and the depth of chill was $^{12}/_{32}$ in. (9.5 mm).